ADAPTATION AND VALIDATION OF A COMPUTERIZED DECISION SUPPORT SYSTEM FOR COTTON AND PEANUT PRODUCTION IN OKLAHOMA

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INTRODUCTION

Chapter I of this dissertation is a manuscript to be submitted for publication in Peanut Science, the journal of the American Peanut Research and Education Society; Chapter II is a manuscript to be submitted for publication in the Journal of Cotton Science, a journal of the Cotton Foundation; and Chapter III is a manuscript to be submitted for publication in Weed Technology, a journal of the Weed Science Society of America.

Chapter I

Adaptation and Validation of HADSS^{TM}

Peanut (*Arachis hypogaea* L.) Production in Oklahoma

Running Title: Adaptation and Validation of HADSS^{TM} for Peanut

ABSTRACT

Herbicide Application Decision Support System (HADSS^{TM}) databases were modified in 1999 to adapt them to Oklahoma environmental conditions and to peanut (*Arachis hypogaea* L.) production systems in the state. Four field experiments were conducted from 1999 through 2001 inclusive to validate those adaptations and to determine if HADSS can recommend postemergent (POST) herbicide treatments that are both economical and effective. HADSS-recommended treatments and results were compared to treatments recommended by an Oklahoma State University Weed Scientist designated as the "Expert". Similar herbicides and herbicide combinations were recommended by both HADSS and the Expert. Weed control was good to excellent for crownbeard [*Verbesina enceliodes* (Cav.) Benth. & Hook. F. ex. A. Gray], entireleaf morningglory (*Ipomoea hederacea* var. *integriuscula* Gray), and Texas panicum (*Panicum taxanum* Buckl.). Few differences were noted between the treatments recommended by HADSS and by the Expert. When differences were present, the HADSS treatments yielded and resulted in economic returns that were as good as (and in some cases better than) the Expert. The Oklahoma-adapted HADSS program can 'aid' county and state extension personnel, crop consultants, chemical dealers, and peanut producers in making efficient and economical POST herbicide applications.

Key Words: Peanut, HADSS, computer support system, weed control, in-shell yield, net returns, decision support system.

Weeds are the most important pest in U.S. agriculture in terms of amount of pesticides used to control them (Fernandez-Cornejo and Jans, 1999). Many highly effective POST herbicides are now labeled for peanut that allow producers a number of weed control options during the growing season. Producers have numerous sources of information for weed control recommendations; they can read herbicide labels, extension publications, or contact chemical dealers, crop consultants, and extension personnel or they can rely on their own experience. Farm supply or chemical dealers are the primary sources of information on pest management for most major field crops (Fernandez-Cornejo and Jans, 1999). These sources generally base herbicide recommendations on relative efficacies for the weed species present in the field. The herbicide application recommended may control the weeds present, but it may not always be the most economically beneficial treatment. Wehtje *et al.* (2000) reported that in peanut, a herbicide application can be less effective for control, but can still result in maximum net return. Maximizing profits of crop production is influenced directly by weed interference and indirectly by the control provided by the herbicide (Dieleman *et al.*, 1996). Basing a herbicide application on economics can only be done with information that producers may not have or know, such as, the efficacy of each control option to each weed species present, all herbicide prices and rates labeled for control, how competitive the weed(s) is with the crop, yield reductions that can be attributed to the weed(s) present, and weed(s) that remain after a treatment application (Marra and Carlson, 1983; Coble and Mortensen, 1992; Auld and Tisdell, 1987).

To determine wether a herbicide application is economically beneficial, an economic threshold (ET) must be established beyond which profitable and sustainable weed management decisions can be made (Coble and Mortensen, 1992). Wilkerson *et al.*

(1991) stated that producers' success with POST herbicides greatly depends on their ability to determine when weed densities exceed ET.

The ET is complicated, difficult, and time consuming to calculate; and it will differ between control options that themselves differ in cost. To establish an ET for weeds, a producer must determine the species and populations, know how competitive the weed is to the crop, and the efficacy and costs of control options (Marra and Carlson, 1983). This situation becomes even more complex with multi species weed populations and with different weed sizes and stages of growth. Weed species vary in competitiveness with a specific crop; some species are more competitive than others (Green *et al.*, 1987; Rushing *et al.*, 1985; Rowland *et al.*, 1999).

Several computer decision support systems (DSS) have been developed to aid producers with making herbicide decisions (Wilkerson *et al.*, 1991; Lybecker *et al.*, 1991.; Wiles *et al.*, 1992; Monks *et al.*, 1995; Renner *et al.*, 1999; Sturgill *et al.*, 2001). Such decisions are a daunting task even for extension or research weed scientists who deal with the subject daily (Rankins *et al.*, 1998). The decisions are difficult because of the large number of variables that go into them. Computerized DSS are ideally suited to efficiently integrate a multitude of factors to aid the decision on POST herbicide applications (Monks *et al.*, 1995; Mortensen and Coble, 1991; Wilkerson *et al.*, 1991). A DSS can predict the most economically beneficial treatment based on weed-crop interference, herbicide efficacy, yield loss prediction models, and economic databases for labeled herbicide options (Sturgill *et al.*, 2001). These comparisons would be extremely time consuming, if not impossible, for a producer to calculate without the aid of a computer program.

Wilkerson *et al.* (1991) states that some modifications must be made to a program developed in one region to be used effectively in other regions of the country. For a DSS to be optimally effective, it should be adapted to area in which it will be used because the databases in the system are normally more accurate for the regions in which they were originally developed and validated. When used outside of its region of adaptation the computer program HERB was not accurate in predicting effects of weeds on soybean [*Glycine max* (L.) Merr.] yield (Monks *et al*., 1995; Green and Martin, 1992; Castner and Banks, 1989). Castner and Banks (1989) showed that HERB consistently overestimated net returns from herbicide treatments at three experimental locations. Validation work in Mississippi indicated that an unmodified HERB program predicted yield losses within 10% of actual yield losses in only 10% of modeling runs and overestimated them in 62% of runs (Ruscoe *et al*., 1994).

After adaptation, a DSS can become more reliable. Mississippi State University adapted HERB to reflect conditions in Mississippi (MSU-HERB) for soybean (Rankins *et al*., 1998). Results from their work indicated that changes in competitive indices and efficacy ratings could improve the utility of HERB for local environments. Where a large difference existed between herbicides recommended by HERB and MSU-HERB, improved weed control resulted from herbicides advocated by MSU-HERB. Soybean yield and net economic gain following MSU-HERB recommendations was as high or higher than HERB recommendations (Rankins *et al*., 1998).

The evaluation of various DSS programs has shown increased weed control, lower management costs, and increased net returns can result with the use of these programs (Forcella *et al*. 1996; Buhler *et al*. 1997; Rankins *et al* 1998; Scott *et al*., 2001, 2002). However, White and Coble (1997) cautioned that a DSS is to supplement the knowledge and experience of the user and is not intended to replace it; therefore, they should be used as "decision aids". HERB was designed to aid the producer and not to relieve that person of making the final decision (Wilkerson *et al.*, 1991).

HADSS, developed at North Carolina State University, formerly HERB, was designed to aid producers, extension personnel, and private consultants in determining economic and effective herbicide treatments for weed control in corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), peanut, and soybean in specific states (Sturgill *et al.*, 2001; Wilkerson *et al.*, 1991). HADSS provides output information on potential crop loss, recommends action to be taken, and predicts the economic consequences of taking the recommended action vs. alternative actions after the user enters the appropriate data regarding field and crop information (Sturgill *et al.*, 2001).

An Oklahoma-adapted HADSS should allow peanut producers in the state to improve weed management strategies, increase herbicide economic returns, and reduce unnecessary herbicide applications. Oklahoma State University received HADSS in 1999. Since that time, many changes have been made in its databases adapting the program to Oklahoma. Weed species lists, competitive indices, herbicide efficacies, and herbicide rates were altered to reflect Oklahoma environmental conditions and herbicide labels. The Oklahoma database differs greatly from that of North Carolina. In some cases, less than 1% commonality in treatment efficacy exists between the two (Price *et al.*, 2002). The changes to the database were made based on research data and literature (where available) and on an Oklahoma State University weed scientist's judgment when the data and literature were not available. This adjusted version of HADSS should better represent Oklahoma peanut production systems and give herbicide recommendations more suitable for Oklahoma environmental conditions than did the original version

Materials and Methods

Four experiments were established from 1999 to 2001 at two locations. One experiment was conducted each year at the Caddo Research Station near Ft. Cobb, OK, and one experiment was performed in 2000 at the Agronomy Research Station near Perkins, OK. Soils at those locations were a Cobb fine sandy loam (a fine-loamy, mixed, active, thermic Typic Haplustalf) with a pH of 7.1 and a 0.7% organic matter content at Ft. Cobb and a Teller fine sandy loam (a fine-loamy, mixed, active, thermic Udic Argiustoll) with a pH of 6.2 and an organic matter content of 0.4% at Perkins.

A spanish peanut cultivar, Tamspan 90, was planted in all experiments at a seeding rate of 90 kg/ha. The peanut rows were established on preformed beds at the Ft. Cobb location. The planting dates at Ft. Cobb were 25, 15, and 16 May in 1999, 2000, and 2001, respectively, and 18 May 2000 at Perkins. Randomized complete-block experimental designs were employed with 10 treatments and four replications. The HADSS computer support system was used to recommend POST herbicide applications for four treatments. Four treatments had POST herbicide applications recommended by an Oklahoma State University weed scientist designated as the "Expert". Additional treatments were a check, which was kept weed free through the use of herbicides, hand weeding, and hoeing and a weedy check which received no herbicides in 1999, but received a preplant incorporated (PPI) application in 2000 and 2001. Plots were four rows wide with 0.9 m row widths and were 15 m long.

All experiments were planted on sites that had moderate-to-high weed populations prior to establishment. In 1999, ethalfluralin [*N*-ethyl-*N*-(2-methyl-2-propenyl)-2,6-

dinitro-4-(trifluoromethyl)benzenamine] at 840 g ai/ha was applied PPI and used on five of the treatments, including the weed-free check. Weed populations were excessively high in 1999 where no PPI herbicide was applied. At all locations in 2000 and 2001, a PPI application of ethalfluralin at 840 g ai/ha was applied to the entire experimental area and additional preemergence (PRE) herbicides were applied immediately after planting to reduce the weed population to a level similar to producers' production systems. When validating a DSS, Ruscoe *et al.* (1994) intentionally selected sites with weed infestations similar to growers fields. Diclosulam [*N*-(2,6-dichlorophenyl)-5-ethoxy-7-fluoro[1,2,4]triazolo[1,5-*c*]pyrimidine-2-sulfonamide] at 12 g ai/ha was applied PRE on five treatments, including the weed-free check and flumioxazin [2-[7-fluoro-3,4-dihydro-3-oxo-4-(2-propynyl)-2*H*-1,4-benzoxazin-6-yl]-4,5,6,7-tetrahydro-1*H*-isoindole-1,3(2*H*)-dione] at 47.7 g ai/ha was applied PRE on four other treatments. The weedy check did not receive an additional PRE herbicide. Two different herbicides were applied PRE in an attempt to change the weed spectrum in half of the treatments so that HADSS and the Expert would have different weed species and populations for which to make recommendations. Scott *et al.* (2002) also used ethalfluralin PPI followed by diclosulam or flumioxazin PRE in their HADSS peanut validation experiments.

Throughout the growing season, preliminary scouting of the experiments was conducted. If those examinations revealed weed populations that would likely require a POST herbicide application, the experiments were then formally scouted on a plot-by-plot basis. Weed species and densities were scouted the day POST applications were made, and the results were used as a basis for HADSS and Expert POST herbicide recommendations. Plots were scouted in the center two rows of each plot to determine weed species present, density (total number of each species per plot), and weed height. The information was averaged across replications for each treatment and then converted to weed density in a 9.3 m^2 area, the format required by HADSS (Sturgill *et al.*, 2001). In 1999, if plant densities were greater than 100 plants/m^2 then three 1 m^2 counts were made in each plot; and the densities were extrapolated to the required format for the DSS. The average weed height was averaged across replications and also entered into HADSS in the appropriate format of small (<5 cm), medium (5 to 10 cm), or large (>10 cm) (Sturgill *et al.*, 2001). An estimate of weed-free yield, required by the DSS, was entered based on the crop, current growing conditions, and average yield associated with that area of peanut production (Oklahoma Agricultural Statistics Service, 1999).

HADSS POST treatments used were the first recommended treatment option based on the highest predicted net return. Many times, the weed species and densities were similar; and HADSS would recommend the same POST treatment. In 1999, if such a duplication would occur, it was avoided by selecting the recommendation with the next highest net return. The first recommended treatment was always used in 2000 and 2001 resulting in several treatment duplications. The Expert recommended herbicide treatments that would result in a high net return, effective weed control, or both. The Expert avoided treatment duplication by selecting different herbicides or rates. The experiments were frequently observed after the POST applications. If inadequate weed control resulted or weeds emerged in numbers that might require an additional application, the fields were once again formally scouted and additional POST applications were made if the DSS or Expert so recommended them. This resulted in three POST applications in 1999, but only one POST application was required in 2000 and 2001.

In 1999, POST applications were made at ground crack on 04 June when the average weed size was classified as small in HADSS, on 16 June with a medium average weed height, and on 17 July at a large weed size. The one POST application in 2000 was made on 30 June with a large average weed size. In 2001, the POST application was made on 06 July with a large weed height in HADSS.

Tables 1 and 2 show the herbicides that were actually applied in the Ft. Cobb experiments. The weed sizes at the POST applications ranged from the cotyledon to 10-leaf stage, with 1 to 125 plants/m^2 depending on the year and treatment. All POST herbicides were applied with the appropriate nonionic surfactant (Latron AG-98, containing 80% alkylaryl polyoxyethylene glycol from Rohm and Haas Co., Philadelphia, PA) or crop oil concentrate (Agri-Dex, a heavy range paraffin base petroleum oil, polyol fatty acid esters, and polyethoxylated derivatives from Helena Chemical Co., Memphis, TN). Herbicides were applied with a tractor-mounted, compressed-air sprayer calibrated to deliver 140 L/ha at a 110 kPa. The POST herbicides applied were: 2,4-DB [4-(2,4-dichlorophenoxy)butanoic acid]; acifluorfen [5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid]; bentazon [3-(1-methylethyl)-(1)-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide]; clethodim [(*E*,*E*)-(±)-2-[1-[[(3-chloro-2-propenyl)oxy]imino]propyl]-5-[2-(ethylthio)propyl]-3-hydroxy- 2-cyclohexen-1-one]; imazapic [(±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid]; imazethapyr [2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-ethyl-3- pyridinecarboxylic acid]; and paraquat (1,1'-dimethyl-4,4'-bipyridinium ion). Similar treatments for the Perkins experiment were not provided because weed populations never reached a level in which POST applications were necessary.

Visual weed control and crop injury ratings were taken at 2, 4, and 8 wk after the last POST treatment (WAT). Only the 8 WAT weed control ratings are reported herein. Ratings were based on a scale of 0 (no control or injury) to 100% (complete control or death of the crop). The center two rows of each plot were dug, the peanut plants were inverted and allowed to dry, they were machine combined, and yields per plot in kg per ha were determined. Herbicide application net returns were determined using a 5-yr moving average peanut price of $0.33/kg in 1999, and $0.32/kg in 2000, and $0.32/kg in 2001 (Oklahoma Agricultural Statistics Service, 2001), along with current herbicide prices averaged from two Oklahoma chemical suppliers. Herbicide variable costs were calculated as the total cost of all herbicides, adjuvants, and applications above what the weedy check received. Costs of application were calculated as $7.95/ha, the average cost for a herbicide application in Oklahoma (Kletke and Doye, 2000). Adjusted herbicide net return was used for economic comparisons among treatments, and it was calculated as total return (peanut yield times average price) minus herbicide variable costs minus total return for the weedy check. The adjusted herbicide net return is the same as the predicted "net return" found in HADSS (Wilkerson *et al.*,1991; Sturgill *et al.*, 2001). Scouting costs associated with the treatments were excluded.

In analyses of the experiments, if a HADSS treatment duplication occurred, the treatments were combined because they had received exactly the same PPI, PRE, and POST herbicide(s). Due to unequal and unlike treatments, weed control, in-shell yield, and adjusted net return are presented separately by location. Data were subjected to ANOVA; and treatment means were separated using Fisher's protected LSD test at P = 0.05. (SAS, 1999).

Results and Discussion

No significant visual crop injury was noted at any rating time; therefore, those data are not shown.

Treatments Recommended. In all 3 yr, the herbicide and herbicide combinations recommended by HADSS were similar to those of the Expert and many times consisted of the same herbicide or herbicide combinations as well as rates (Tables 1 and 2). In 1999 at the ground crack application, all herbicides used in HADSS treatments were used in Expert treatments except for 2,4-DB (Table 1). The Expert recommended a "do not spray" for two treatments while HADSS recommended an application be made in all four treatments. HADSS generally recommended fewer early POST applications of herbicides than did the Expert. The Expert recommended a three-way herbicide tank mix in three treatments and HADSS recommended one three-way tank mix, one two-way tank mix, and two single herbicide applications. Every herbicide recommended by HADSS, in 1999, with the exception of imazapic, was recommended by the Expert either alone or in some combination.

Table 2 shows the herbicides recommended by HADSS and the Expert for 2000 and 2001. In 2000, the herbicides used were the same for HADSS and the Expert. An Expert treatment with diclosulam PRE received clethodim alone while all other treatments received a tankmix of 2,4-DB plus clethodim. HADSS recommended higher use rates than did the Expert. With a large weed size, i.e., the weed size according to the HADSS format, HADSS will generally recommend the higher rates. The Expert varied rates depending on density and size for each treatment. These type situations are where the

DSS is limited, and experience and other resources can help a producer use lower herbicide rates. A similar situation occurred in 2001, HADSS and the Expert recommended exactly the same herbicide tank mixes for all treatments, and the same rates for an Expert treatment with flumioxazin PRE and one with diclosulam PRE. In two treatments, Expert with flumioxazin PRE and Expert with diclosulam PRE, the Expert recommended half the rate for both 2,4-DB and clethodim.

Weed Control. Weed control for both HADSS and the Expert POST treatments for 8 WAT were generally good to excellent (Tables 3, 4, and 5). Crownbeard was evaluated in 1999 and 2001 but was not evaluated in 2000 due to the experimental site having lower populations of that weed due to excellent control from the PRE herbicides. Entireleaf morningglory and Texas panicum were evaluated in all 3 yr. The weed density in the weedy check was greatest in 1999. Crownbeard, entireleaf morningglory, and Texas panicum densities were 320, 99, and 95 plants/9.3 m^2, respectively, at the first POST application. The densities were lower in 2000 and 2001 and similar to what would be expected in producers' fields. In 2000 at the POST application, densities of 45 and 36 plants/9.3 m^2 of entireleaf morningglory and Texas panicum, respectively, were present in the weedy check. In 2001, the densities (number per 9.3 m^2) in the weedy check at the POST application were 26 for crownbeard, 15 for entireleaf morninglory, and 14 for Texas panicum. In 1999, the herbicides recommended (Table 1) were generally for the control of crownbeard because it was the dominant species. Herbicide efficacy changes were made to the database after the first season due to poorer than expected control with some ground crack and early POST herbicide treatments (data not shown).

Crownbeard control was ≥85% with all POST treatments 8 WAT (Tables 3 and 5). Grichar and Sestak (2000) reported that crownbeard can be controlled effectively with the use of a multifaceted system using PPI/PRE herbicides followed by POST herbicides. The two lowest crownbeard control ratings are in 1999 (Table 3), a HADSS with no PPI and a Expert with no PPI. In 1999, generally higher control can be associated for crownbeard when the treatments received a PPI application. Crownbeard control with HADSS recommended treatments ranged from 85 to 99%, while the control from the Expert recommendations ranged from 89 to 99%. With a PPI application, one HADSS recommended treatment was equal to the two Expert recommended treatments and while the other HADSS recommended treatment was lower, it still had 90% crownbeard control. Control of crownbeard was excellent in 2001, ranging from 95 to 98% control (Table 5). HADSS POST treatment crownbeard control was equal to the Expert control, with no differences between the recommendation source.

Entireleaf morningglory control ranged from 85 to 100% control for both HADSS and the Expert recommended treatments. In 1999, control from the HADSS recommended treatments were equal to the Expert recommended treatments and the weed-free check with the exception of one HADSS with no PPI, still at 85% control (Table 3). In 2000, entireleaf morningglory control for the HADSS recommended treatments ranged from 91 to 94% while the Expert recommendations ranged from 89 to 95%. Control from the HADSS recommendations was the same as the control from the Expert recommendations and the weed-free check. In 2001, control of entireleaf morningglory was 95 and 100% for the HADSS treatments and ranged from 89 to 96%

for the Expert treatments (Table 5). HADSS recommended treatments had as high or higher control than the Expert recommended treatments and was equal to the weed-free check. The reduced rate of 2,4-DB recommended in the one Expert treatment with diclosulam PRE probably resulted in the lower control of entirleaf morningglory than the recommended HADSS treatments and the other Expert treatment with diclosulam PRE.

Texas panicum control ranged from 77 to 98% control during the three years. When compared among alike soil-applied programs, Texas panicum control for HADSS recommended treatments was equal to the Expert recommendations in all 3 yr (Tables 3, 4, and 5). In 1999, control of Texas panicum ranged from 86 to 96% for HADSS recommendations and 89 to 98% for the Expert recommended treatments (Table 3). There were no differences in control between treatments recommended by HADSS or the Expert when compared among treatments that received a PPI application. With no PPI application one HADSS treatment had higher control than an Expert and the other HADSS treatment. In 2000, Texas panicum control was good for both the HADSS and the Expert recommended treatments with no differences among them but all were lower than the weed-free check (Table 4). The HADSS recommended treatments had 91 and 93% control while the Expert treatments ranged from 89 to 93% control. The Expert used several reduced rates of clethodim which were as effective as the high rate recommended by HADSS. Texas panicum control ranged from 80 to 90% and 77 to 95% for the HADSS and Expert recommended treatments, respectively, in 2001 (Table 5). The recommended treatments from the HADSS and one Expert with diclosulam PRE resulted in control equal to the weed-free check. There were no differences in control between the HADSS and the Expert treatments within the same soil-applied program.

Peanut Yield. There were few differences in peanut yield between HADSS, the Expert, and the weed-free check treatments in all 3 yr (Tables 3, 4, and 5). HADSS recommended treatments yielded as high or higher than the Expert recommended treatments in 1999, 2000, and 2001. In 2000, for an unexplainable reason one treatment recommended by the Expert had a lower yield than all other recommended treatments. The weedy check yield was consistently the lowest of all treatments, 1999 had the greatest reduction in yield compared to the other treatments followed by 2000 and then 2001. This gradual decrease in yield reduction difference can probably be attributed to reduced weed densities. In 1999, the lowest yielding treatment was the weedy check with 608 kg/ha, which was six to seven times lower than the other treatments (Table 3). The weed-free check was numerically, but not statistically, higher than the HADSS and Expert recommended treatments. Yield for the HADSS treatments ranged from 3548 to 4020 kg/ha while the Expert treatments yield ranged from 3539 to 4138 kg/ha with no difference in yield between the recommending sources. Table 4 shows the yield for the weedy check was 1825 kg/ha, lower than all other treatments. There were no differences in yield between and among the recommended HADSS treatments, Expert treatments, and the weed-free check, with the exception of one Expert treatment with flumioxazin PRE. In 2001, there were no differences in yield between and among the HADSS treatments, Expert treatments, and weed-free check (Table 5). The weedy check was lower than all other treatments with 2206 kg/ha, the difference between the weedy check and the average of the other treatments was less than the difference in 1999 and 2000.

Adjusted Herbicide Net Returns. The adjusted herbicide net returns were similar to the results of the peanut yield. There were few differences in adjusted net return between HADSS recommended treatments and the Expert recommended treatments in all 3 yr (Table 3, 4, and 5). Recommended treatments from HADSS had adjusted herbicide net returns as high or higher than the Expert treatments in 1999, 2000, and 2001. In 1999 the large yield difference between the weedy check and the other treatments resulted in high adjusted herbicide net returns (Table 3). There were no differences between HADSS and the Expert recommended treatments for adjusted herbicide net return in 1999. The adjusted herbicide net return ranged from \$898 to 1121/ha and \$939 to 1151/ha for the HADSS and Expert recommended treatments, respectively. In 2000, few differences were observed in the adjusted herbicide net returns (Table 4). An Expert treatment with flumioxazin PRE was lower than one HADSS recommended treatment and two Expert recommended treatments. The adjusted net returns for the HADSS treatments were \$307 and 343/ha, while the Expert treatments ranged from \$201 to 341/ha. Adjusted net returns were the same between the HADSS and the Expert recommended treatments in 2001 (Table 5). The HADSS recommendations had adjusted net returns of \$87 and 110/ha while the Expert recommended treatments ranged from \$83 to 187/ha.

HADSS was as effective at recommending herbicide treatments that resulted in similar herbicides, good weed control, comparable yields and adjusted herbicide net returns to treatments recommended by a human expert. The weed control resulting from the HADSS recommendations were generally as effective as the treatments recommended by the Expert. The yields and the adjusted net returns were the same or higher for the HADSS recommended treatments compared to the Expert recommended treatments. This indicates that HADSS, adapted for Oklahoma, can be an effective economic tool to aid producers, state and county extension personnel, consultants, or users in selecting a POST herbicide application.

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Table 1. **Postemergence (POST) treatments recommended by HADSS and Expert in 1999 following a preplant incorporated (PPI) herbicide or none at Ft. Cobb, OK.**

Soil-applied PPI	Recomm. source[a]	POST timing[b], herbicides and rates: Ground crack	Early POST	Late POST
		g ai/ha		
Ethalfluralin[c]	HADSS	Imazethapyr (71) 2,4-DB (280)	Acifluorfen (420)	Imazapic (72) 2,4-DB (280)
Ethalfluralin	Expert	Imazethapyr (71)	Bentazon (560) Acifluorfen (280)	Bentazon (560) Acifluorfen (280)
Ethalfluralin	HADSS	Paraquat (144) 2,4-DB (140)	Imazethapyr (71) 2,4-DB (280)	Acifluorfen (420) 2,4-DB (280)
Ethalfluralin	Expert	Do Not Spray	Bentazon (560) Acifluorfen (420) 2,4-DB (280)	2,4-DB (280) Clethodim (280)
None	HADSS	Imazethapyr (71) 2,4-DB (280)	Paraquat (144) Bentazon (560) Acifluorfen (280)	Clethodim (280)
None	Expert	Paraquat (144)	Bentazon (560) Acifluorfen (420) 2,4-DB (280)	2,4-DB (280) Clethodim (280)
None	HADSS	Imazethapyr (71)	Acifluorfen (420)	Imazapic (72) 2,4-DB (280)
None	Expert	Do Not Spray	Bentazon (560) Acifluorfen (420) 2,4-DB (280)	2,4-DB (280) Clethodim (280)

[a]Recommendation source.
[b]Ground crack, early POST, and late POST applications were made on 04 June, 16 June, and 17 July, respectively.
[b]Ethalflurafin was applied at 840 g ai/ha.

Table 2. **Postemergence (POST) treatments recommended by HADSS and Expert in 2000 and 2001 following a preplant incorporated (PPI) and preemergence (PRE) herbicides at Ft. Cobb, OK.**[a]

Soil-applied PRE	Recomm. source[b]	POST timing[c], herbicides and rates 2000	2001
		(g ai/ha)	
Flumioxazin[d]	HADSS	2,4-DB (280) Clethodim (280)	2,4-DB (280) Clethodim (280)
Flumioxazin	Expert	2,4-DB (220) Clethodim (140)	2,4-DB (280) Clethodim (280)
Flumioxazin	Expert	2,4-DB (280) Clethodim (210)	2,4-DB (140) Clethodim (140)
Diclosulam[e]	HADSS	2,4-DB (280) Clethodim (280)	2,4-DB (280) Clethodim (280)
Diclosulam	Expert1	Clethodim (140)	2,4-DB (280) Clethodim (280)
Diclosulam	Expert2	2,4-DB (220) Clethodim (140)	2,4-DB (140) Clethodim (140)

[a]Each experimental area received a PPI application of ethalfluralin at 840 g ai/ha.
[b]Recommendation source.
[c]POST applications were made on 30 June and 06 July in 2000 and 2001, respectively.
[d]Flumioxazin was applied at 47.7 g ai/ha.
[e]Diclosulam was applied at 12.0 g ai/ha.

Table 3. **Weed control, yield, and adjusted net return as effected by herbicide treatment in 1999 at Ft. Cobb, OK.**

Soil-applied	Recomm.[a]	Weed control at 8 WAT[b]			In-shell	Adjusted
PPI	source	VEEEN	IPOHE	PANTE	yield	net return
		%			(kg/ha)	($/ha)
Ethalfluralin[c]	HADSS	99 a[d]	98 a	93 bc	3548 abc	898 a
Ethalfluralin	Expert	99 a	98 a	98 ab	3830 ab	1061 a
Ethalfluralin	HADSS	90 bc	97 a	90 bc	3694 ab	1023 a
Ethalfluralin	Expert	98 a	99 a	98 ab	4138 a	1151 a
None	HADSS	85 c	85 b	96 b	4020 ab	1121 a
None	Expert	98 a	98 a	94 bc	3539 abc	939 a
None	HADSS	95 ab	99 a	86 c	3902 ab	1055 a
None	Expert	89 c	95 a	89 c	3576 ab	981 a
Weed-free	Check	100 a	100 a	100 a	4142 a	--
Weedy	Check	0 d	0 c	0 d	608 d	--

[a]Abbreviations: Recomm., recommendation; WAT, weeks after treatment; VEEEN, crownbeard; IPOHE, entireleaf morningglory; PANTE, Texas panicum.

[b]Data taken 8 weeks after the last POST application.

[c]Ethalfluralin was applied at 840 g ai/ha.

[d]Means within the same column followed by the same letter were not significantly different as determined by Fisher's protected LSD test at P=0.05.

Table 4. **Weed control, yield, and adjusted net return as effected by herbicide treatment in 2000 at Ft. Cobb, OK.**

Soil-applied[a] PRE	Recomm.[b] source	Weed control 8 WAT[c] IPOHE	Weed control 8 WAT[c] PANTE	In-shell yield	Adjusted net return
		%	%	(kg/ha)	($/ha)
Flumioxazin[d]	HADSS	91 ab[e]	93 b	3076 a	307 ab
Flumioxazin	Expert	89 b	93 b	3106 a	338 a
Flumioxazin	Expert	95 a	93 b	2648 b	201 b
Diclosulam[f]	HADSS	94 ab	91 b	3201 a	343 a
Diclosulam	Expert	91 ab	91 b	2949 ab	341 a
Diclosulam	Expert	93 ab	89 b	3087 a	290 ab
Weedfree	Check	100 a	100 a	3149 a	--
Weedy	Check	0 c	0 c	1825 c	--

[a]Ethalfluralin was applied PPI to the entire experiment area at 840 g ai/ha.
[b]Abbreviations: Recomm., recommendation; WAT, weeks after treatment; IPOHE, entireleaf morningglory; PANTE, Texas panicum.
[c]Data taken 8 weeks after the last POST application.
[d]Flumioxazin was applied PRE at 47.7 g ai/ha.
[e]Means within the same column followed by the same letter were not significantly different as determined by Fisher's protected LSD test at P=0.05.
[f]Diclosulam was applied PRE at 12.0 g ai/ha.

Table 5. **Weed control, yield, and adjusted net return as effected by herbicide treatment in 2001 at Ft. Cobb, OK.**

Soil-applied[a] PRE	Recomm.[b] source	Weed control at 8 WAT[c] VEEEN	IPOHE	PANTE	In-shell yield	Adjusted net return
		%			(kg/ha)	($/ha)
Flumioxazin[d]	HADSS	96 a[e]	95 abc	80 c	2830 a	87 a
Flumioxazin	Expert	98 a	94 abc	78 c	2897 a	107 a
Flumioxazin	Expert	95 a	90 bc	77 c	3067 a	187 a
Diclosulam[f]	HADSS	96 a	100 a	90 abc	2938 a	110 a
Diclosulam	Expert	96 a	96 ab	95 ab	2992 a	126 a
Diclosulam	Expert	96 a	89 c	85 bc	2736 a	83 a
Weed-free	Check	100 a	100 a	100 a	3002 a	--
Weedy	Check	0 b	0 d	0 d	2206 b	--

[a]Ethalfluralin was applied PPI to the entire experiment area at 840 g ai/ha.
[b]Abbreviations: Recomm., recommendation; WAT, weeks after treatment; IPOHE, entireleaf morningglory; PANTE, Texas panicum.
[c]Data taken 8 weeks after the last POST application.
[d]Flumioxazin was applied PRE at 47.7 g ai/ha.
[e]Means within the same column followed by the same letter were not significantly different as determined by Fisher's protected LSD test at P=0.05.
[f]Diclosulam was applied PRE at 12.0 g ai/ha.

Chapter II

Adaptation and Validation of HADSS^{TM} for Cotton (*Gossypium hirsutum* L.) Production in Oklahoma

COVER PAGE

TITLE:	Adaptation and Validation of HADSS™ for Cotton (*Gossypium hirsutum* L.) Production in Oklahoma
DISCIPLINE:	Weed Management
AUTHORS:	Shea Murdock

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<u>BLIND</u> COVER PAGE

TITLE: Adaptation and Validation of HADSS™ for Cotton (*Gossypium hirsutum* L.) Production in Oklahoma

LIST OF ABBREVIATIONS

DSS	Decision Support System
ET	Economic Threshold
HADSS™	Herbicide Application Decision Support System
POST	Postemergence
PPI	Preplant Incorporated
PRE	Preemergence
WAT	Weeks After Treatment

Interpretive Summary

Weed control is an important component of cotton production and many producers use postemergent (POST) herbicides in weed control management systems. The decision to apply a POST herbicide that is effective and economical is difficult and complex. To choose the most economically beneficial POST herbicide treatment, a producer must be able to determine economic thresholds or know the competitive nature for each weed species present in the field and compare the price and effectiveness of each possible POST treatment option. HADSS™ is a computer program, developed at North Carolina State University, designed to aid producers with making these difficult and often complex decisions.

In 1999, HADSS databases were modified to better represent Oklahoma cotton production systems. Field experiments were conducted in 1999 and 2000 to validate the program and modified databases to determine if it could recommend efficient and economical POST treatments. HADSS and an Oklahoma State University weed scientist "Expert" each recommended POST herbicide treatments following varying pre-plant and preemergence herbicide programs.

HADSS recommended POST herbicide and herbicide combinations that were similar to the recommendations of the Expert. When compared within alike pre-plant and preemergence herbicide programs, there were few differences for weed control, cotton lint yield, and adjusted herbicide net return between the HADSS and the Expert recommended treatments. Weed control, of eight weed species, from the HADSS recommended treatments were generally equivalent to the control from the Expert recommended treatments. Cotton lint yield was also similar between the two recommending sources.

Net returns from HADSS recommended treatments were the same or higher than the net returns resulting from the Expert recommended treatments.

Our results suggest that an Oklahoma adapted version of HADSS can recommend POST treatments that are as effective and economical as an Expert. The program can aid county and state extension personnel, crop consultants, dealers, and cotton producers with making POST herbicide applications in cotton. HADSS is not intended to be used as the sole source for weed control decisions but only to aid in the decision.

ABSTRACT

The decision to make an effective and economical postemergent (POST) herbicide application is often difficult and complex. The addition of glyphosate-tolerant and bromoxynil-resistant cotton (*Gossypium hirsutum* L.) has given producers more POST weed control options but at the same time has made the decision more complex. HADSS^{TM} is a computer program, developed at North Carolina State University, designed to aid with this decision. HADSS^{TM} databases from North Carolina were modified, in 1999, to adapt them to Oklahoma agronomic conditions and cotton production systems. Seven field experiments, planted with either glyphosate-tolerant or bromoxynil-resistant cultivars, were conducted during 1999 and 2000 to validate the changes and determine if HADSS can recommend POST herbicide treatments that were both effective and economical. HADSS recommended treatments and results were compared to treatments recommended by an Oklahoma State University Weed Scientist (Expert). Similar herbicides and herbicide combinations were recommended by both HADSS and the Expert. Weed control, for eight weed species in both cultivar types, using both HADSS and the Expert POST recommended treatments were similar when they received like preplant or preemergence herbicide programs. HADSS treatments yielded and resulted in economic returns that were as good and in some cases better than the Expert, for both cultivars, when receiving the same preemergence herbicide program. The adapted program can aid county and state extension personnel, crop consultants, dealers, and peanut producers with making efficient and economical POST herbicide applications.

Weed control is an essential component to cotton production with weeds being the most important pest in U.S. Agriculture in terms of share of pesticide treatments used to control them (Fernandez-Cornejo and Jans, 1996). According to national statistics, herbicides were applied to 95% of cotton acreage in 1999 (USDA, 2001); and in 1996, of the acreage that received a herbicide application, approximately 67% was treated with a postemergent (POST) herbicide (Fernandez-Cornejo and Jans, 1996). The introduction of genetically enhanced cotton has given producers more POST herbicide control options during the growing season but has also made the decision to apply a POST herbicide more complex.

Producers have many potential sources of information for weed control recommendation; they can read herbicide labels, extension publications, or contact chemical dealers, crop consultants, and extension personnel or rely on past experiences. Farm supply or chemical dealers are the primary source of information on pest management for major field crops (Fernandez-Cornejo and Jans, 1996). These sources of information generally base herbicide applications on efficacies for the weed species present in the field. The herbicide application recommended may control the weeds present but it may not be the most economically beneficial treatment.

Maximizing profits and expected profits of crop production are influenced directly by weed interference and indirectly by the control provided by the POST herbicide (Dieleman et al., 1996). Basing a herbicide application on economics can only be done with information that producers may not have or know, such as, the efficacy of each control option to each weed species present, all herbicide prices and rates labeled for use, how competitive the weed(s) is to the crop, and yield reduction that can be attributed to the weed(s) present and weed(s) that will remain after a treatment application (Marra and Carlson, 1983; Coble and Mortensen, 1992; Auld and Tisdell, 1987).

To determine when a herbicide application is economically beneficial, an economic threshold (ET) has to be established which offers a method by which profitable and sustainable weed management decisions can be made (Coble and Mortensen, 1992). Wilkerson (1991) stated that a producer's success with POST herbicides greatly depends on their ability to detect the point in where weed densities exceed ET.

The ET is complicated, difficult, and time consuming to calculate; and it will differ between control options that differ in cost, as herbicide and application cost increase the ET will increase, with other factors held constant (Coble and Mortensen, 1992). To establish an ET for weeds, a producer must be able to determine the population, know the competitive nature of the weed to the crop (how much the weed will reduce yield if not controlled), and the efficacy and costs of the control options (Marra and Carlson, 1983). This situation becomes even more complex with the multi-species weed populations and different weed sizes and stages of growth. Weed species vary in their competitiveness to cotton, some species are more competitive than others (Green et al., 1987; Rushing et al., 1985; Rowland et al., 1999).

There have been several computer decision support systems (DSS) developed to aid producers with making herbicide decisions (Wilkerson et al., 1991; Lybecker et al., 1991.; Wiles et al., 1992; Monks et al., 1995; Renner et al., 1999; Sturgill et al., 2001). Herbicide application decisions are a daunting task even for extension or research weed scientists who deal with the subject daily (Rankins et al., 1998). The decisions are difficult because of the large number of variables that go into the decision. Computerized decision aids are ideally suited to efficiently integrate the multitude of factors, such as, extensive weed-crop interference, weed population databases, herbicide efficacy, and economic databases; in a manner to aid the decision on herbicide application (Monks et al., 1995; Mortensen and Coble, 1991; Wilkerson et al., 1991). A DSS can predict the most economically beneficial POST treatment based on weed-crop interference, herbicide efficacy, yield loss prediction models, and economic databases for labeled herbicide options (Sturgill et al., 2001). These results would be extremely time consuming if not impossible for a producer to calculate without the aid of a computer program.

Wilkerson et al. (1991) states that some modifications should be made to the program in order to be used in other regions of the country. For a DSS to be optimally effective, it should be adapted to the state or region in which it will be used because the databases which are in the system are normally more accurate for the regions in which they were developed and validated. This will allow for a program to recommend herbicides that are labeled and recommendations that will benefit the local user. When used outside of the region of adaptation, HERB did not accurately predict effects of weeds on soybean yield (Monks et al., 1995; Green and Martin, 1992; Castner and Banks, 1989). Castner and Banks (1989) reported that HERB consistently overestimated predicted net returns of herbicide treatments at three experiment locations. Validation work in Mississippi indicated an unmodified HERB predicted yield losses within 10% of actual yield losses in approximately 10% of the modeling runs, and overestimated yield loss in 62% of the modeling runs (Ruscoe et al., 1994).

Upon adaptation, a DSS can become more reliable. Mississippi State University adapted MSU-HERB to reflect conditions in Mississippi for soybean (Rankins et al., 1998). Results from Rankins et al. (1998) indicated that changes in competitive indices and efficacy ratings can improve the utility of HERB for local environments from a weed control standpoint. In instances where a large difference in herbicide efficacy existed between herbicides recommended by HERB and MSU-HERB, improved weed control resulted from herbicides recommended by MSU-HERB. Soybean yield and net economic gain following MSU-HERB recommendations was as high or higher than HERB recommendations (Rankins et al., 1998).

The evaluation of various DSS programs have shown an increased weed control, lower management costs, and increased net returns can result with the use of these programs (Forcella et al. 1996; Buhler et al. 1997; Rankins et al 1998; Scott et al., 2001, 2002). White and Coble (1997) stated that a DSS purpose is to supplement the knowledge and experience of the user, and not replace it, therefore they should be used only as a 'decision aid'. HERB was designed to aid the producer and not to attempt to relieve the decision maker of the final decision (Wilkerson et al., 1991).

HADSS™ (Herbicide Application Decision Support System), developed at North Carolina State University, formally HERB, was designed to aid producers, extension personnel, and private consultants in determining an economic and effective herbicide treatment for weed control in corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), peanut, and soybean [*Glycine max* (L.) Merr.] in specific states (Sturgill et al., 2001; Wilkerson et al., 1991). HADSS will provide output information on potential crop loss, recommend action to be taken, and predict economic results of taking the recommended action or an alternative action after the user enters data regarding field and crop information (Sturgill et al., 2001).

An Oklahoma adapted HADSS may allow producers in the state to improve weed management strategies, increase herbicide economic returns, and reduce unnecessary herbicide applications. Oklahoma State University received HADSS in 1999, since that time there have been many changes to the databases adapting the program to Oklahoma production systems. Weed species lists, competitive indices, herbicide efficacies, and herbicide rates were altered to reflect Oklahoma conditions and herbicide labels. The Oklahoma cotton database differs greatly from the North Carolina database and there is less than 1% commonality in treatment efficacy between the two databases (Price et al., 2002). The changes to the database were made based on research data and literature where available, and on Oklahoma State University weed scientist's judgement when not available.

This adjusted version of HADSS should better represent the biology and agronomy of Oklahoma production systems and give herbicide recommendations more suitable for Oklahoma conditions. The objectives of the study were to validate the modified version HADSS and determine if it could recommend POST herbicide applications that were as effective and economical as an Oklahoma State University Weed Scientist.

Materials and Methods

Seven field experiments were established in 1999 and 2000 at three locations. The locations included the Agronomy Research Station near Perkins, OK in 1999 and 2000, at the Southwest Research and Extension Center near Altus, OK in 1999, and at the South Central Research Station near Chickasha, OK in 2000. Soils were a Navina loam (fine-loamy, mixed, active, Udic Argiustolls) with a pH of 6.1 and an organic content of 0.5%

at Perkins, a Tillman-Hollister clay loam (fine, smectitic, thermic Typic Haplusterts) with a pH of 8.1 and a 1.1% organic matter content at Altus, and a Dale silt loam (fine-silty, mixed, superactive, thermic Pachic Haplustolls) with a pH of 7.2 and an organic matter content of 0.5% at Chickasha.

There were two experiments at each location each year, one experiment at each location was planted to a glyphosate-tolerant cultivar, 'Paymaster 1220 BG/RR' while the other experiment was planted to a bromoxynil-resistant cultivar 'Stoneville BXN 47' , except at the Perkins site in 2000 when the bromoxynil-resistant experiment was dropped due to poor stand establishment. In both cultivars, cotton was planted at 14 seeds m^{-1} in plots that were 15.2 m long and four cotton rows wide. Row widths were 1.0 m at the Altus location and were 0.9 m at all other locations.

The experimental design was a randomized complete block design with 10 treatments and four replications. The treatments consisted of a weedy check, which in some cases received a pre-plant incorporated application; and a weed-free check, which was kept weed free through the use of herbicides, hand weeding, and hoeing. The remaining eight treatments consisted of: four treatments in which HADSS was used to select the postemergence herbicide treatments and an Oklahoma State University weed scientist (Expert) selected the postemergence herbicide treatments for the other four treatments. Two of the HADSS and Expert treatments received a different preemergent herbicide program than the other two in hopes of changing the weed spectrum in half of the treatments so there would be a different weed species and populations to recommend the POST herbicides.

In 1999 at the Perkins locations, half of the treatments in the experiments, including the weed free check, received a PPI application of trifluralin [2,6-dinitro-*N*, *N*-dipropyl-4-(trifluoromethyl)benzenamine] at 1.1 kg ai ha^{-1} and was planted on 26 May. In Altus, trifluralin was applied to the entire experiment at 1.1 kg ai ha^{-1} on 1 March to preformed beds and incorporated with a rolling cultivator set to conform to the beds, half of the treatments including the weed free check received an application of 2.2 kg ai ha^{-1} prometryn [*N*,*N'*-bis(1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine] on 2 June immediately following planting. While in 2000 the entire experiments at Perkins and Chickasha received a 0.8 and 1.1 kg ai ha^{-1} rate of trifluralin and then half the treatments, including the weed-free check, received an additional application of prometryn at 1.1 and 1.8 kg ai ha^{-1} immediately after planting on 23 May and 22 May, respectively. Scott et al. (2001) used trifluralin PPI and an additional PRE herbicide in their HADSS evaluation experiments.

All experiments were established on sites that had moderate to high weed populations prior to establishment. Throughout the growing season preliminary scouting of the experiments were made, if these examinations revealed weed populations that would likely result in a POST herbicide application, the experiments were then scouted on a plot by plot basis. The plots were scouted in the center rows of each plot to determine weed species, density (total number of each weed per plot), and height. The information was averaged across replications for each treatment and then converted to weed density in a 9.3 m^{-2} area, the format required by HADSS (Sturgill et al., 2001). In 1999, plant densities were high and three 1 m^{-2} counts were made in each plot while in 2000 the entire center rows were counted and then densities were extrapolated to the required format of the DSS. The average weed height was averaged across replication and also entered into

HADSS in the appropriate format of small (0 to 5 cm), medium (5 to 10 cm), or large (>10 cm) (Sturgill et al., 2001). A weed-free yield, required by the DSS, was entered based on the crop, current growing condition, and average yield associated with that area of cotton production (Oklahoma Agriculture Statistics Service, 1999).

Weed species and densities were scouted the day POST applications were made and the results from the scouts were used as a basis for HADSS and the Expert POST herbicide recommendations. HADSS POST treatments were selected from the first recommended treatment option based on the greatest predicted net return, many times the weed species and densities were similar between the treatments and HADSS would recommend the same POST treatment resulting in a duplication of treatments. In 1999, if a duplication would have occurred, it was avoided by selecting the recommendation with the next highest net return. The first recommended treatment was always selected in 2000 sometimes resulting in treatment duplications. The Expert recommended herbicide treatments that would result in a high net return, effective weed control, or both. The Expert avoided treatment duplication by selecting different herbicides or rates.

POST treatments were duplicated with preplant herbicide applications for both the HADSS and the Expert, HADSS and the Expert recommended the POST treatment for two treatments that received the same preemergence herbicide treatment (i.e., in 1999 at Perkins HADSS selected the POST herbicides for two treatments that received trifluralin PPI and two that received no PPI, and the same for the Expert).

The experiments were continually observed after the POST applications, if inadequate weed control resulted or more weeds emerged in numbers that might require an additional POST application, the fields were once again scouted and additional POST applications were made if HADSS or the Expert recommended.

All POST herbicides were applied with the appropriate nonionic surfactant (Latron Ag-98, containing 80% alkylaryl polyoxyethylene glycol from Rohm and Haas Co., Philadelphia, PA) or crop oil concentrate (Agri-dex, a heavy range paraffin base petroleum oil, polyol fatty acid esters, and polyethoxylated derivatives from Helena Chemical Co., Memphis, TN). Herbicides were applied with a tractor-mounted, compressed-air sprayer calibrated to deliver 140 L/ha at a 110 kPa. The POST herbicides applied were: bromoxynil, 3,5-dibromo-4-hydroxybenzonitrile; fluazifop-P (R)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanoic acid; glyphoste, N-(phosphonomethyl)glycine; MSMA, monosodium salt of MAA; and pyrithiobac, 2-chloro-6-[(4,6-dimethoxy-2-pyrimidinyl)thio]benzoic acid (Tables 1 to 7).

In 1999 at the Perkins location, the POST application were made on 18 June (early POST) and 9 July (Mid POST) for both cultivars. The Palmer amaranth (*Amaranthus palmeri* S.Wats.) population, in the weedy check at early POST, was over 1000 plants per 9.3 m^{-2}, while the large crabgrass [*Digitaria sanguinalis* (L.) Scop.] had about 10 plants. In the glyphosate-tolerant experiment, fluazifop was recommended and applied in two treatments, as a followed-by option, on 12 July, 3 d after the mid POST. Due to a sporadic large crabgrass population in the bromoxynil-resistant experiment, all treatments received an application of fluazifop at 1.1 kg ai ha^{-1} on 12 July 1999. The Perkins experiments were grown in a dryland production system and received no irrigation.

The experiments at Altus were furrow irrigated seven times throughout the growing season. The POST applications were made on 15 June and 13 July 1999 for the early and mid POST, respectively. The weed populations per 9.3 m^{-2}, in the weedy check at early POST) were 118 and 14 for pitted morningglory (*Ipomoea lacunosa* L.) and johnsongrass [*Sorghum halepense* (L.) Pers.], respectively. Due to a sporadic Johnsongrass population in the bromoxynil-resistant experiment, all treatments received an application of fluazifop at 1.1 kg ai ha^{-1} on 8 July 1999.

In 2000 at Perkins, the early POST was applied on 23 June. The populations at the early POST application for entireleaf morningglory (*Ipomoea hederacea* var. *integriuscula* Gray), devil's-claw [*Proboscidea louisianica* (Mill.) Thellung], common cocklebur (*Xanthium strumarium* L.), and velvetleaf (*Abutilon theophrasti* Medicus) were 3, 9, 2, and 2 per 9.3 m^{-2}, respectively, in the weedy check. The experiment was irrigated twice with a side-roll sprinkler irrigation system during the growing season.

The experiments at Chickasha received herbicide applications on 16 June (early POST) and 13 July (mid POST). The common cocklebur populations in the weedy check were 35 and 4 per 9.3 m^{-2} for the bromoxynil-resistant and the glyphosate-tolerant cultivars, respectively. The experiments were irrigated with a side-roll sprinkler irrigation system three times during the growing season.

Visual weed control of Palmer amaranth, large crabgrass, pitted morningglory, johnsongrass, entireleaf morningglory, Devil's claw, common cocklebur, and velvetleaf and crop injury ratings were taken at 4, 6, and 8 weeks after POST treatment (WAT). Ratings were based on a scale of 0 (no control or injury) to 100% (complete control or death of the crop). The center two rows of each plot were harvested with a commercial brush roller stripper, and lint yields were measured. Herbicide application net returns were determined with a 5-yr moving average cotton lint prices of \$1.43 kg^{-1} in 1999 and \$1.26 kg^{-1} in 2000 (Oklahoma Agriculture Statistics Services, 2001), along with current herbicide prices averaged from two Oklahoma chemical suppliers. Herbicide variable cost were calculated as the total cost of all herbicide, adjuvants, and application cost above what the weedy check treatment received. Costs of application was calculated as \$7.95/ha, the average cost for a herbicide application in Oklahoma (Kletke and Doye 2000). Adjusted herbicide net return was used for economic comparisons for the recommended treatments and was calculated as total return (cotton lint yield times average price) minus herbicide variable cost minus total return for the weedy check treatment. The adjusted herbicide net return is the same as the predicted "net return" found in HADSS (Wilkerson et al.,1991; Sturgill et al., 2001). Scouting costs associated with the treatments were excluded. Seed technology cost was not assessed as a variable cost to any of the treatments, since the DSS was not equipped to handle technology fees with cultivar type and the decision to plant a herbicide resistant crop had been made at planting date, prior to the decision of a POST herbicide application.

In analysis of the experiments, if a HADSS treatment duplication occurred the treatments were combined since they had received exactly the same herbicide(s) PPI, PRE, and POST. Due to unequal and unlike treatments and different weed species present, the weed control, yield, and adjusted net return data are presented separately by location. Data were subjected to ANOVA and treatment means were seperated by Fisher's protected LSD at P = 0.05 (SAS, 1999).

Results and Discussion

Weed Control.

Weed control data presented was taken 8 WAT. The weed species are discussed individually, but in all experiments in which they were evaluated..

Palmer amaranth

Palmer amaranth control was ≥85% with all POST treatments 8 WAT when a preemergence soil-applied herbicide was used (Tables 8 to 11). With no preemergence soil-applied herbicide the control ranged from 48 to 100%. HADSS recommended treatments had 10 of 16 in which control was equal to the weed-free check while the Expert had 11 of 16 recommended treatments. In alike soil-applied herbicide regimes, HADSS recommendations, generally, had control similar to the Expert recommendations. In 1999 at Perkins, HADSS recommended treatments provided control that was as high or higher than the Expert treatments when comparing within alike soil-applied regimes (Tables 8 and 9). At Altus there was a HADSS recommended treatment in the glyphosate-tolerant and one in the bromoxynil-resistant experiments that had lower control than an Expert treatment, in alike soil-applied programs (Tables 10 and 11). For effective management of Palmer amaranth a preemergence soil-applied herbicide program should be used in conjunction with a POST applied herbicide (Scott et al., 2001; Keeling et al.; 1991).

Large Crabgrass

Large crabgrass was evaluated at only one site, glyphosate-tolerant cotton at Perkins in 1999, and control was 100% for both HADSS and Expert recommended treatments when trifluralin was applied PPI and ranged from 65 to 94% with no trifluralin (Table 8). Compared to the weed-free check, only one HADSS recommended treatment had lower control while the Expert had two treatments that had lower control than the weed-free check. With no trifluralin, both the HADSS recommended treatments had a higher control than the two Expert treatments, this can probably be contributed to the fluazifop treatment recommended by HADSS in both treatments at the mid POST application. Previous research has shown that fluazifop can effectively control large crabgrass (Smeda and Putnam, 1989).

Pitted Morningglory

Pitted morningglory was evaluated at the Altus locations where control ranged from 84 to 100% (Table 10 and 11). HADSS had 3 of 8 and the Expert had 4 of 8 recommended treatments that were equal to the weed-free check. When comparing within alike soil-applied herbicide regimes, all HADSS treatments were equal to the Expert treatments, with only one exception in the glyphosate-tolerant cotton but still had a 95% control rating. Generally, there was better POST control when the treatments received both a PPI and PRE herbicide application.

Johnsongrass

Johnsongrass control was ≥91% in the glyphosate-tolerant experiment at Altus (Table 10). Control from HADSS recommended treatments ranged from 91 to 100% and the Expert recommended treatments ranged from 95-100%. The only recommended treatment that was lower than the weed-free check was a HADSS treatment. This treatment was also lower than a HADSS and Expert recommended treatment that received a PRE application. The treatments that had higher control received glyphoste at the early POST timing, probably resulting in the higher control.

Entireleaf Morningglory

Entrieleaf morningglory, evaluated only in the glyphosate-tolerant experiment, control ranged from 95 to 100% control for the HADSS and Expert recommended treatments at Perkins in 2000 (Table 12). All recommended treatments were equal to the weed-free check with the exception of one HADSS treatment that did not receive a PRE herbicide but still had 95% control. The control within alike soil-applied regimes was the same for the recommending sources.

Devil's-claw

Devil's-claw control for the HADSS recommended treatments were 97 and 99% while the Expert treatments ranged from 81 to 98%, in the glyphosate-tolerant experiment at Perkins in 2000 (Table 12). Control in the HADSS treatments were equal to the weed-free check while only 2 of 4 of the Expert treatments were equal. Within alike soil-applied herbicide regimes HADSS recommended treatments had as high or higher control than the Expert treatments.

Common Coklebur

Control of common cocklebur ranged from 75 to 100% for the recommending sources (Tables 12, 13, and 14). HADSS recommended treatments ranged from 80 to 100% while the Expert recommended treatments ranged from 75 to 100%. Control, when compared within alike soil-applied herbicide regimes, from the HADSS recommended treatments were equal to the Expert recommended treatments in the glyphosate-tolerant cotton at Perkins and bromoxynil-resistant cotton at Chickasha and was as high or higher in the glyphosate-tolerant cotton at Chickasha. Control of common cocklebur was equal to the weed-free check in 4 of 7 HADSS recommended treatments and 6 of 12 Expert recommended treatments across all three experiments.

Velvetleaf

Control of velvetleaf was 97 and 98% for HADSS recommended treatments and ranged from 86 to 100% for the Expert treatments (Table 12). HADSS recommended treatments were equal to the weed-free check while the Expert had 3 of 4 treatments equal. All recommended treatments were equal with the exception of one Expert treatment that had lower control of 86%.

Cotton Lint Yield. In general, there were few differences in cotton lint yield between HADSS and the Expert recommended treatments in both years (Tables 8 to 14). HADSS recommended treatments yielded equal to the weed-free check in 20 of 23 treatments while the Expert recommended treatments had 19 of 28 treatments equal across the seven experiments. Scott et al. (2001) had similar results, when a soil-applied plus HADSS POST system yielded equal to the weed-free check on 10 of 12 comparisons.

Within alike soil-applied herbicide regimes, HADSS and the Expert recommended treatments had equal cotton lint yields with the exception of the glyphosate-tolerant cotton at Altus; where HADSS recommended treatment cotton lint yields were as high or higher than the Expert treatment lint yields. Lint yields from all the recommended treatments of HADSS and the Expert and the weed-free check were higher than the weedy check. There was crop injury of 12, 13, and 9% in a HADSS treatment without a PRE, a HADSS treatment with a PRE, and an Expert treatment with a PRE, respectively, in the glyphosate-tolerant cotton at Chickasha (data not shown). This injury was probably due to the mid POST application of MSMA (Table 6), and probably resulted in the reduced yields for these treatments (Table13). Shankle et al. (1996) reported cotton lint yield reduction with an application of MSMA POST. Lower weed populations in 2000 for the glyphosate-tolerant experiments at Perkins and Chickasha resulted in a smaller difference in cotton lint yield between the recommended treatments and the weedy check (Table 12 and 13).

Adjusted Herbicide Net Returns

The adjusted herbicide net returns were similar to the results of the cotton lint yield (Tables 8 to 14). The adjusted herbicide net returns resulted in positive net returns for all recommended treatments with the exceptions of an Expert treatment at Perkins in 2000. When no PPI herbicide was applied the adjusted net returns were generally lower when compared to the recommended treatments that received a PPI application (Tables 8 and 9). When comparing among alike soil-applied herbicide regimes there were no differences between HADSS and Expert recommended treatments in 9 of 14 comparisons for all seven experiments. When there was a difference, HADSS recommended treatment adjusted net returns were as high or higher than the Expert treatments. In the situations when HADSS treatments had a higher adjusted net return than the Expert recommended treatments, 3 of 5 had no difference in cotton lint yield; therefore, much of the difference can be attributed to a higher cost associated with the Expert recommended treatment. The experiments at Perkins in 1999 and 2000, generally had smaller adjusted net returns due to less yield when compared to the other experiments (Tables 8, 9, and 12). The smaller difference in cotton lint yield between the recommended and weedy check treatments, due to low weed populations, reduced the adjusted net returns in the glyphosate-tolerant experiments at Perkins and Chickasha in 2000 (Table 12 and 13). The lower yields for the recommended treatments and the low weed populations both contributed to the negative net return for the Expert recommended treatment in 2000 at Perkins.

HADSS recommended POST herbicide treatments resulted in similar herbicides, good weed control, comparable yields and adjusted herbicide net returns to treatments recommended by an Expert for both the glyphosate-tolerant and bromoxynil-resistant experiments. The weed control resulting from the HADSS recommendations were generally equivalent to the treatments recommended by the Expert. When compared within alike soil-applied herbicide regimes, the cotton lint yields and the adjusted net returns were the same or higher for the HADSS recommended treatments compared to the Expert recommended treatments. This indicates that HADSS, adapted for Oklahoma cotton production, can be an effective economic tool to aid producers, state and county extension personnel, consultants, or other users in selecting a POST herbicide application.

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Table 1. Postemergence treatments in glyphosate-tolerant cotton as recommended by HADSS and Expert in 1999, following either none or a trifluralin PPI soil-applied herbicide program at Perkins.

Soil-applied	Recom.† source	Postemergence application timing and herbicides rates	
		Early POST	Mid POST
(PPI)		(kg ai ha^{-1})	
Trifluralin‡	HADSS	Glyphosate (1.1)	Pyrithiobac (0.04)
Trifluralin	Expert	Glyphosate (0.8)	No Treatment
Trifluralin	HADSS	No Treatment	Pyrithiobac (0.04)
Trifluralin	Expert	Glyphosate (1.1)	Cultivation
None	HADSS	Glyphosate (1.1)	Pyrithiobac (0.07) fb§ Fluazifop (1.1)
None	Expert	Pyrithiobac (0.07) MSMA (1.1)	Pyrithiobac (0.07) MSMA (1.1)
None	HADSS	Pyrithiobac (0.07)	Pyrithiobac (0.07) fb Fluazifop (1.1)
None	Expert	Glyphosate (0.8)	Pyrithiobac (0.07)

†Abbreviations: Recom., recommendation; PPI, preplant incorporated.

‡Trifluralin was applied at 1.1 kg ha^{-1}.

§Fluazifop was applied 3 d later.

Table 2. Postemergence treatments in bromoxynil-resistant cotton as recommended by HADSS and Expert in 1999, following either none or a trifluralin PPI soil-applied herbicide program at Perkins.

Soil-applied	Recom.† source	Postemergence application timing and herbicides rates	
		Early POST	Mid POST
(PPI)		(kg ai ha^{-1})	
Trifluralin‡	HADSS	Pyrithiobac (0.04)	No treatment
Trifluralin	Expert	Pyrithiobac (0.07)	No treatment
Trifluralin	HADSS	No treatment	Pyrithiobac (0.07)
Trifluralin	Expert	Bromoxynil (0.6)	Pyrithiobac (0.07)
		Pyrithiobac (0.04)	
None	HADSS	Pyrithiobac (0.07)	Pyrithiobac (0.07)
None	Expert	Bromoxynil (0.6)	Pyrithiobac (0.07)
None	HADSS	Pyrithiobac (0.07)	Pyrithiobac (0.07)
		MSMA (1.1)	
None	Expert	Bromoxynil (0.6)	Pyrithiobac (0.07)
		Pyrithiobac (0.04)	

†Abbreviations: Recom., recommendation; PPI, preplant incorporated.

‡Trifluralin was applied at 1.1 kg ha^{-1}.

Table 3. Postemergence treatments in glyphosate-tolerant cotton as recommended by HADSS and Expert in 1999, following either none or a prometryn PRE soil-applied herbicide program at Altus.

Soil-†	Recom.‡	Postemergence application timing and herbicides rates	
applied	source	Early POST	Mid POST
(PRE)		(kg ai ha^{-1})	
Prometryn§	HADSS	Pyrithiobac (0.07)	Pyrithiobac (0.07)
Prometryn	Expert	Pyrithiobac (0.07)	Pyrithiobac (0.04)
		MSMA (1.1)	MSMA (1.1)
Prometryn	HADSS	Glyphosate (1.1)	Pyrithiobac (0.07)
Prometryn	Expert	Pyrithiobac (0.07)	Pyrithiobac (0.04)
		Glyphosate (0.8)	MSMA (1.1)
None	HADSS	Glyphosate (1.1)	Pyrithiobac (0.07)
None	Expert	Pyrithiobac (0.07)	Pyrithiobac (0.07)
		MSMA (1.1)	MSMA (1.1)
None	HADSS	Glyphosate (1.1)	Pyrithiobac (0.04)
None	Expert	Pyrithiobac (0.07)	Pyrithiobac (0.04)
			MSMA (1.1)

†Trifluralin was applied PPI to the entire experiment area at 1.1 kg ai ha^{-1}.

‡Abbreviations: Recom., recommendation; PPI, preplant incorporated.

§Prometryn was applied at 2.2 kg ai ha^{-1}.

Table 4. Postemergence treatments in bromoxynil-resistant cotton as recommended by HADSS and Expert in 1999, following either none or a prometryn PRE soil-applied herbicide program at Altus.

Soil-† applied	Recom.‡ source	Postemergence application timing and herbicides rates	
		Early POST	Mid POST
(PRE)		(kg ai ha^{-1})	
Prometryn§	HADSS	Pyrithiobac (0.07)	Bromoxynil (0.6)
Prometryn	Expert	Pyrithiobac (0.07) MSMA (1.1)	Pyrithiobac (0.07) MSMA (1.1)
Prometryn	HADSS	Bromoxynil (0.6)	Bromoxynil (0.6)
Prometryn	Expert	Bromoxynil (0.6)	Pyrithiobac (0.07) MSMA (1.1)
None	HADSS	Pyrithiobac (0.07)	Bromoxynil (0.6)
None	Expert	Pyrithiobac (0.07)	Pyrithiobac (0.07) MSMA (1.1)
None	HADSS	Pyrithiobac (0.07) MSMA (1.1)	Bromoxynil (0.6)
None	Expert	Bromoxynil (0.6)	Pyrithiobac (0.07) MSMA (1.1)

†Trifluralin was applied PPI to the entire experiment area at 1.1 kg ai ha^{-1}.

‡Abbreviations: Recom., recommendation; PRE, preemergence.

§Prometryn was applied at 2.2 kg ai ha^{-1}.

Table 5. Postemergence treatments in glyphosate-tolerant cotton as recommended by HADSS and Expert in 2000, following either none or a prometryn PRE soil-applied herbicide program at Perkins.

Soil-† applied (PRE)	Recom.‡ source	Postemergence herbicide rates Early POST
		——— (kg ai ha^{-1}) ———
None	HADSS	Glyphosate (1.1)
None	Expert	Glyphosate (1.1)
None	Expert	Pyrithiobac (0.05)
		MSMA (1.1)
Prometryn§	HADSS	Glyphosate (1.1)
Prometryn	Expert	Pyrithiobac (0.06)
Prometryn	Expert	Pyrithiobac (0.09)

†Trifluralin was applied PPI to the entire experiment area at 0.8 kg ai ha^{-1}.

‡Abbreviations: Recom., recommendation; PRE, preemergence.

§Prometryn was applied at 1.1 kg ai ha^{-1}.

Table 6. Postemergence treatments in glyphosate-tolerant cotton as recommended by HADSS and Expert in 2000, following either none or a prometryn PRE soil-applied herbicide program at Chickasha.

Soil-† applied (PRE)	Recom.‡ source	Postemergence application timing and herbicides rates	
		Early POST	Mid POST
		(kg ai ha^{-1})	
None	HADSS	MSMA (1.1)	MSMA (1.1)
None	Expert	MSMA (1.1)	No treatment
None	Expert	Glyphosate (1.1)	No treatment
Prometryn§	HADSS	MSMA (1.1)	MSMA (1.1)
Prometryn	Expert	Glyphosate (1.1)	Pyrithiobac (0.05)
			MSMA (1.1)
Prometryn	HADSS	MSMA (1.1)	No Treatment
Prometryn	Expert	Pyrithiobac (0.04)	Pyrithiobac (0.07)

†Trifluralin was applied PPI to the entire experiment area at 1.1 kg ai ha^{-1}.

‡Abbreviations: Recom., recommendation; PRE, preemergence.

§Prometryn was applied at 1.8 kg ai ha^{-1}.

Table 7. Postemergence treatments in bromoxynil-resistant cotton as recommended by HADSS and Expert in 2000, following either none or a prometryn PRE soil-applied herbicide program at Chickasha.

Soil-† applied	Recom.‡ source	Postemergence application timing and herbicides rates	
		Early POST	Mid POST
(PRE)		——— (kg ai ha^{-1}) ———	
None	HADSS	MSMA (1.1)	Bromoxynil (0.6)
None	Expert	Pyrithiobac (0.07)	Bromoxynil (0.4)
			MSMA (1.1)
None	Expert	Bromoxynil (0.6)	Pyrithiobac (0.07)
Prometryn§	HADSS	MSMA (1.1)	Bromoxynil (0.6)
Prometryn	Expert	Bromoxynil (0.6)	Bromoxynil (0.6)
Prometryn	Expert	Pyrithiobac (0.07)	Bromoxynil (0.6)
			Pyrithiobac (0.07)

†Trifluralin was applied PPI to the entire experiment area at 1.1 kg ai ha^{-1}.

‡Abbreviations: Recom., recommendation; PRE, preemergence.

§Prometryn was applied at 1.8 kg ai ha^{-1}.

Table 8. Weed control, yield, and adjusted net return in glyphosate-tolerant cotton as effected by herbicide treatment in 1999 at Perkins.

Soil-applied	Recom.† source	Weed control 8 WAT‡ AMAPA	DIGSA	Lint yield	Adjusted net return
(PPI)		——— % ———		(kg ha^{-1})	(\$ ha^{-1})
Trifluralin§	HADSS	95 a¶	100 a	332 abc	355 ab
Trifluralin	Expert	100 a	100 a	328 abc	395 a
Trifluralin	HADSS	99 a	100 a	346 ab	414 a
Trifluralin	Expert	99 a	100 a	339 abc	412 a
None	HADSS	94 a	94 ab	296 abc	277 bc
None	Expert	76 b	65 d	273 c	217 c
None	HADSS	75 b	88 b	295 abc	233 c
None	Expert	82 b	79 c	283 bc	288 bc
Trifluralin	Weed-free	100 a	100 a	354 a	--
None	Weedy	0 c	0 e	14 d	--

† Abbreviations: Recom., recommendation; WAT, weeks after treatment; AMAPA, Palmer amaranth; DIGSA, large crabgrass; PPI, preplant incorporated.

‡Data taken 8 weeks after the last POST application.

§Trifluralin was applied PPI at 1.1 kg ai ha^{-1}.

¶Means within the same column followed by the same letter were not significantly different as determined by Fisher's protected LSD test at P=0.05.

Table 9. Weed control, yield, and adjusted net return in bromoxynil-resistant cotton as effected by herbicide treatment in 1999 at Perkins.

Soil-applied	Recom.† source	Weed control 8 WAT‡ AMAPA	Lint yield	Adjusted net return
(PPI)		——— % ———	(kg ha^{-1})	(\$ ha^{-1})
Trifluralin§	HADSS	98 a¶	309 a	364 a
Trifluralin	Expert	99 a	310 a	330 a
Trifluralin	HADSS	94 a	317 a	340 a
Trifluralin	Expert	100 a	304 a	263 b
None	HADSS	66 b	190 b	92 c
None	Expert	48 d	187 b	146 c
None	HADSS	68 b	231 b	136 c
None	Expert	55 c	211 b	143 c
Trifluralin	Weed-free	100 a	328 a	--
None	Weedy	0 e	12 c	--

†Abbreviations: Recomm., recomendation; WAT, weeks after treatment; AMAPA, Palmer amaranth; PPI, preplant incorporated.

‡Data taken 8 weeks after the last POST application.

§Trifluralin was applied PPI at 1.1 kg ai ha^{-1}.

¶Means within the same column followed by the same letter were not significantly different as determined by Fisher's protected LSD test at P=0.05.

Table 10. Weed control, yield, and adjusted net return in glyphosate-tolerant cotton as effected by herbicide treatment in 1999 at Altus.

Soil-† applied	Recom.‡ source	Weed control 8 WAT§ IPOLA	AMAPA	SORHA	Lint yield	Adjusted net return
(PRE)		%			(kg ha^{-1})	($ ha^{-1})
Prometryn¶	HADSS	100 a♯	100 a	91 b	1296 a	1114 ab
Prometryn	Expert	100 a	100 a	96 ab	1246 a	1059 b
Prometryn	HADSS	95 b	100 a	100 a	1289 a	1143 ab
Prometryn	Expert	97 ab	100 a	100 a	1228 ab	1054 b
None	HADSS	98 ab	91 bc	98 ab	1270 a	1153 ab
None	Expert	94 b	98 ab	95 ab	1128 b	893 c
None	HADSS	95 b	86 c	96 ab	1284 a	1173 a
None	Expert	95 b	98 ab	98 ab	1128 b	902 c
Prometryn	Weed-free	100 a	100 a	100 a	1277 a	--
None	Weedy	0 c	0 d	0 c	381 c	--

†Trifluralin was applied PPI to the entire experiment area at 1.1 kg ai ha^{-1}.

‡Abbreviations: Recom., recommendation; WAT, weeks after treatment; IPOLA, pitted morningglory; AMAPA, Palmer amaranth; SORHA, johnsongrass; PRE, preemergence.

§Data taken 8 weeks after the last POST application.

¶Prometryn was applied PRE at 2.2 kg ai ha^{-1}.

♯Means within the same column followed by the same letter were not significantly different as determined by Fisher's protected LSD test at P=0.05.

Table 11. Weed control, yield, and adjusted net return in bromoxynil-resistant cotton as effected by herbicide treatment in 1999 at Altus.

Soil-† applied	Recom.‡ source	Weed control 8 WAT§ IPOLA	AMAPA	Lint yield	Adjusted net return
(PRE)		——— % ———		(kg ha^{-1})	(\$ ha^{-1})
Prometryn¶	HADSS	88 bc#	100 a	1275 a	1294 a
Prometryn	Expert	93 ab	100 a	1204 a	1117 a
Prometryn	HADSS	93 ab	100 a	1255 a	1323 a
Prometryn	Expert	93 ab	100 a	1253 a	1253 a
None	HADSS	84 c	88 b	1224 a	1266 a
None	Expert	90 bc	100 a	1200 a	1166 a
None	HADSS	88 bc	95 a	1237 a	1268 a
None	Expert	84 c	85 b	1178 a	1191 a
Prometryn	Weed-free	100 a	100 a	1257 a	--
None	Weedy	0 c	0 e	268 b	--

†Trifluralin was applied PPI to the entire experiment area at 1.1 kg ai ha^{-1}.

‡Abbreviations: Recomm., recomendation; WAT, weeks after treatment; IPOLA, pitted morningglory; AMAPA, Palmer amaranth; PRE, preemergence.

§Data taken 8 weeks after the last POST application.

¶Prometryn was applied PRE at 2.2 kg ai ha^{-1}.

#Means within the same column followed by the same letter were not significantly different as determined by Fisher's protected LSD test at P=0.05.

Table 12. Weed control, yield, and adjusted net return in glyphosate-tolerant cotton as effected by herbicide treatment in 2000 at Perkins.

Soil-† applied	Recom.‡ source	Weed control 8 WAT§				Lint yield	Adjusted net return
		IPOHE	PROLO	XANST	ABUTH		
(PRE)		%				(kg ha^{-1})	(\$ ha^{-1})
None	HADSS	95 b¶	99 a	98 a	97 a	447 ab	124 ab
None	Expert	98 ab	98 a	93 a	100 a	502 a	191 a
None	Expert	98 ab	91 ab	100 a	86 b	416 b	52 bc
Prometryn#	HADSS	98 ab	97 a	100 a	98 a	443 ab	83 bc
Prometryn	Expert	98 ab	88 bc	100 a	100 a	467 ab	70 bc
Prometryn	Expert	100 a	81 c	93 a	100 a	415 b	-11 c
Prometryn	Weed-free	100 a	100 a	100 a	100 a	463 ab	--
None	Weedy	0 c	0 d	0 b	0 c	315 c	--

†Trifluralin was applied PPI to the entire experiment area at 0.8 kg ai ha^{-1}.

‡Abbreviations: Recom., recommendation; WAT, weeks after treatment; IPOHE, entireleaf morningglory; PROLO, Devil's-claw; XANST, common cocklebur; ABUTH, velveltleaf; PRE, preemergence.

§Data taken 8 weeks after the last POST application.

¶Means within the same column followed by the same letter were not significantly different as determined by Fisher's protected LSD test at P=0.05.

#Prometryn was applied PRE at 1.1 kg ai ha^{-1}.

Table 13. Weed control, yield, and adjusted net return in glyphosate-tolerant cotton as effected by herbicide treatment in 2000 at Chickasha.

Soil-† applied	Recom.‡ source	Weed control 8 WAT§ XANST	Lint yield	Adjusted net return
(PRE)		——— % ———	(kg ha^{-1})	($ ha^{-1})
None	HADSS	94 a¶	480 ab	244 ab
None	Expert	75 c	548 ab	346 a
None	Expert	76 c	591 a	378 a
Prometryn♯	HADSS	94 a	456 b	178 bc
Prometryn	Expert	91 ab	445 b	89 c
Prometryn	HADSS	80 bc	514 ab	267 ab
Prometryn	Expert	79 c	534 ab	186 bc
Prometryn	Weed-free	100 a	585 a	--
None	Weedy	0 d	260 c	--

†Trifluralin was applied PPI to the entire experiment area at 1.1 kg ai ha^{-1}.

‡Abbreviations: Recom., recommendation; WAT, weeks after treatment; XANST, common cocklebur; PRE, preemergence.

§Data taken 8 weeks after the last POST application.

¶Means within the same column followed by the same letter were not significantly different as determined by Fisher's protected LSD test at P=0.05

♯Prometryn was applied PRE at 1.8 kg ai ha^{-1}.

Table 14. Weed control, yield, and adjusted net return in bromoxynil-resistant cotton as effected by herbicide treatment in 2000 at Chickasha.

Soil-† applied	Recom.‡ source	Weed control 8 WAT§ XANST	Lint yield	Adjusted net return
(PRE)		—— % ——	(kg ha^{-1})	(\$ ha^{-1})
None	HADSS	85 b¶	551 a	606 a
None	Expert	89 b	540 a	522 ab
None	Expert	93 ab	516 a	490 ab
Prometryn♯	HADSS	83 b	531 a	545 a
Prometryn	Expert	88 b	547 a	560 a
Prometryn	Expert	86 b	512 a	386 b
Prometryn	Weed-free	100 a	550 a	--
None	Weedy	0 d	49 b	--

†Trifluralin was applied PPI to the entire experiment area at 1.1 kg ai ha^{-1}.

‡Abbreviations: Recom., recommendation; WAT, weeks after treatment; XANST, common cocklebur; PRE, preemergence.

§Data taken 8 weeks after the last POST application.

¶Means within the same column followed by the same letter were not significantly different as determined by Fisher's protected LSD test at P=0.05

♯Prometryn was applied PRE at 1.8 kg ai ha^{-1}.

Chapter III

Comparison of Weed Counts Vs. Estimates for Input into a Computer Decision Support System

Comparison of Counts Versus Estimations for Obtaining Weed Densities for Input in a Computer Decision Support System

S. W. Murdock

ABSTRACT: Ten field experiments, seven with cotton and three with peanut, were conducted in Oklahoma from 1999 to 2001 to evaluate estimated versus counted weed populations and to determine if the estimated populations have an effect on postemergent herbicide recommended treatments from Herbicide Application Decision Support System (HADSS™) when used as input data. Three estimators estimated the weed populations (#/9.3 m^2, the HADSS format) in every plot, four crop rows wide and 15 m long, and then counts were performed to determine the actual weed population. The research was performed in existing experiments', therefore, plots that had been treated alike chemically, up to the time that estimations and counts were collected, were combined and this resulted in two treatments for each experiment. The estimators, when estimating the weed density, were generally accurate and differed from the counts only in 20% of the estimates across all experiments. The estimations differed from the counts, in the cotton experiments, in only one of 54 estimations, while in peanut 21 out of 54 estimations differed from the count population. Although, 18 of the 21 differences came from one peanut experiment where weed populations were high, the weeds were small, and there were four weeds evaluated. The estimated populations had little effect on the recommended treatments from HADSS. Approximately 65% of the time, the top three recommended treatments when using the estimated populations were identical to the top three recommended treatments when using the count populations. When rankings of the recommended

treatments were different between the counts and estimations, the top three recommended treatments from the counts were always in the top six, and generally in the top four, recommended treatments from the estimated populations. The predicted net returns from the recommended treatments where similar for the weed count and the estimated weed populations.

Nomenclature: Cotton, (*Gossypium hirsutum* L.); peanut (*Arachis hypogaea* L.).

Additional index words: HADSS, scouting, weed estimates, weed counts.

Abreviations: PPI, preplant incorporated; PRE, preemergence.

INTRODUCTION

There have been many weed management models and computerized decision support systems (DSS) developed over the past two decades (Wilkerson et al., 1991; Lybecker et al., 1991.; Wiles et al., 1992; Monks et al., 1995; Renner et al., 1999; Sturgill et al., 2001). These weed management tools have been developed to aid the user when making a herbicide application. HADSS™ (Herbicide Application Decision Support System), developed at North Carolina State University, formally HERB, was designed to aid producers, extension personnel, and private consultants in determining an economic and effective herbicide treatment for weed control in corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), peanut (*Arachis hypogaea* L.), and soybean [*Glycine max* (L.) Merr.] in specific states (Sturgill et al., 2001; Wilkerson et al., 1991). HADSS will provide output information on potential crop loss, recommend action to be taken, and predict economic results of taking the recommended action or an alternative action after the user enters data regarding field and crop information, including weed density information (Sturgill et al., 2001).

When a DSS uses economics to recommend herbicide applications, it is based on the economic threshold by counting emerged weed seedlings and are, generally, for postemergence weed control decisions (Wilkerson et al., 1991). These weed management models rely on accurately estimating the mean weed density to determine whether control measures are needed and to select optimal management technique (Coble and Mortensen, 1992; Wiles et al., 1992).

With this type of DSS, such as HADSS, weed scouting is essential for proper use of the program (Gold et al., 1996). Although, scouting is probably one of the deterrents to widespread adoption of these models because it is time consuming, expensive, and tedious (Gold et al., 1996). Wilkerson et al. (2002) reported that HADSS recommended postemergent treatments are more effective with the more scouting samples taken in a field. HADSS user guide suggests that the field should be scouted, generally about 10 to 12 samples should be taken per field (Sturgill et al., 2001). The suggested sample size is a 9.3 m^{-2} area and the weeds should be counted within that area. The average population across all samples would be the weed densities entered into the program. The guide also suggests that if weed populations are very high that an estimate of number of weeds will suffice because as weeds numbers increase, the effect per weed decreases (Sturgill et al., 2001).

A concern of many researchers working with DSS is that users will not do a proper job of scouting the fields and will possibly estimate the weed populations in the field. The objectives of this research were to determine if weed population estimations are effective in small plot, or sample size areas, compare the estimation populations to actual count populations, and determine if the weed estimations result in different herbicide recommendations when using HADSS.

MATERIALS AND METHODS

There were 10 experiments, seven with cotton and three with peanut, conducted within existing HADSS validation experiments from 1999 to 2001. The validation experiments consisted of 10 treatments with four replications. Plots were four crop rows wide and 15 m long. The research was conducted on Oklahoma State University research stations throughout Oklahoma. Two cotton studies were conducted near Altus, OK, two near Chickasha, OK, and three near Perkins, OK and the three peanut studies were conducted near Ft. Cobb, OK.

Weed population estimations and counts were performed in every plot in the experiments. There were three estimators that estimated the weed populations, the estimators differed between experiments. There were a total of nine estimators and they were weed science graduate students or faculty members at Oklahoma State University. The predominant weed species, in each experiment, were determined prior to the estimations. The estimators estimated the weed population in the HADSS format of #/9.3 m^{-2} and had no knowledge of treatment randomization within an experiment. After estimations had been completed counts were made between rows two and three to determine the actual weed populations. In 1999, weed counts were obtained using three 1 m^{-2} quadrants, while in 2000 and 2001 the entire area between the two center rows were counted, after the count data was obtained the populations were then converted to the required HADSS format.

At Altus, two cotton experiments, the entire experimental area received trifluralin preplant incorporated (PPI) at 1.1 kg/ha, and half of the experiment received an additional application of prometryn preemergence (PRE) at 2.2 kg/ha. One experiment was planted to a glyphosate-tolerant cultivar and the other to a bromoxynil-resistant cultivar. The two predominant weed species at the Altus experiments were pitted morningglory (*Ipomoea lacunosa* L.), IPOLA, and johnsongrass [*Sorghum halepense* (L.) Pers.], SORHA. The counts and estimations were performed when the species were 2 to 8 cm in height.

The Chickasha experiments, two cotton experiments, received trifluralin PPI at 1.1 kg/ha over the entire experimental areas, and half of the experiment received an additional application of prometryn PRE at 1.8 kg/ha. One experiment was planted in a glyphosate-tolerant cultivar and the other to a bromoxynil-resistant cultivar. The predominant weed species at the Chickasha experiments was common cocklebur (*Xanthium strumarium* L.), XANST and it ranged in height from 2 to 5 cm in height when the estimations and counts were performed.

In 1999 at the Perkins location, half of the treatments in the experiments received a PPI application of trifluralin at 1.1 kg ai/ha while the other treatments receive no soil-applied herbicide. Palmer amaranth (*Amaranthus palmeri* S.Wats.), AMAPA, was the predominant weed species in both the glyphosate-tolerant and bromoxynil-resistant cultivars and ranged from 1 to 5 cm in height when data were taken. In 2000 there was only one experiment at Perkins, a glyphosate-tolerant cultivar. The entire experimental area received trifluralin PPI at 0.8 kg/ha and half of the experiment received an additional application of prometryn PRE at 1.1 kg/ha. The two predominant weed species were entireleaf morningglory (*Ipomoea hederacea* var. *integriuscula* Gray), IPOHE, and devil's-claw [*Proboscidea louisianica* (Mill.) Thellung], PROLO, with an average weed height of 5 to 10 cm.

In 1999 at Ft. Cobb, half the experiment received a ethalflurafin PPI application at 0.8 kg/ha while half received no herbicide application up to the time of the counts and estimations. Crownbeard [*Verbesina enceliodes* (Cav.) Benth. & Hook. F. ex. A. Gray], VEEEN; entireleaf morningglory (*Ipomoea hederacea* var. *integriuscula* Gray), IPOHE; Palmer amaranth and Texas panicum (*Panicum taxanum* Buckl.), PANTE; were the weed species counted and estimated with an average weed height of 1 to 5 cm. At Ft. Cobb in 2000 and 2001 the entire experimental areas received a PPI application of ethalflurafin at 0.8 kg/ha and half of the experiment received an additional PRE application of flumioxazin at 0.05 kg/ha while the other half received an application of diclosulam PRE at 0.01 kg/ha. The predominant weed species were entireleaf morningglory and Texas panicum in 2000 and the same in 2001 with the addition of crownbeard, with average weed heights ranging from 8 to 13 cm and 10 to 15 cm each year, respectively .

Since this research was performed in existing experiments, plots that had received the same herbicide treatments up to the time the estimations and counts were performed, were then combined. The combining of plots resulted in two treatments, replicated 20 times, each for the 10 experiments. To obtain the two treatments with alike herbicide programs in the 2000 and 2001 peanut experiments at Ft. Cobb, the weedy check plot from the validation experiments were dropped.

Treatment means were determined for each weed species in all experiments for the weed counts and the three estimators populations. Data were subjected to an ANOVA and treatment means were seperated by Fisher's protected LSD at $P = 0.05$ (SAS, 1999).

HADSS was used to compare the top recommendations and net returns from the actual weed populations, as determined by the counts, to the recommended treatments from each estimators weed populations in both treatments in all experiments. This was done by using input data from the experiments (i.e., crop information, cultivar type, and weed data) and data typical of the area in which the experiment was conducted. All inputs remained the same within an experiment, with the exception of weed populations which were determined from the treatment means for the weed counts or the estimations. The top three recommendations resulting from the weed count populations were recorded with their corresponding net return. The top three recommended treatments from the counts were then found in the list of recommended treatments when using each estimators weed populations; the rank and net returns of the three treatments were recorded to determine the effect of the estimations on treatment recommendation and net return.

RESULTS AND DISCUSSION

Since the experiments had differing weed species, soil-applied herbicide programs, and experimental conditions the experiments were evaluated and will be discussed separately. The weed counts and postemergence recommendations will be discussed individually for each experiment. There were few differences resulting from the estimated weed densities, therefore, only results from three experiments were placed in table format (Tables 1 to 3). These tables are a representative sample of the rest of the experiments, with a glyphosate-tolerant cultivar, a bromoxynil-tolerant cultivar, and a peanut experiment. Generally, the results of the three experiments were similar to all the experiments which data are not shown. The decision to limit the number of tables was to reduce the redundancy and allow this manuscript to be more readable.

At Altus, in the glyphosate-resistant experiment, there were no differences between the weed counts and the estimations for either pitted morningglory or johnsongrass, with the exception of one estimation for johnsongrass with trifluralin PPI (Table 1). Generally, an estimator would be consistently low or high across both weed species in both soil-applied herbicide programs. The estimations for pitted morningglory differed in number from the count from less than 1 weed to 31 weeds. The pitted morningglory population was less in the PPI followed by PRE application, this resulted in a smaller numerical difference between the counts and estimations but a greater percentage difference. This trend was generally seen throughout all of the experiments. With only a PPI application, the estimations were, on average, about 14% different from the count, while in the PPI and PRE treatment the estimations were about 70% different. The few differences in the estimations resulted in little difference in the rank and net return of the postemergence recommended treatments. In all cases, with the exception of estimator B, the rank of the top three recommended treatments were the same for the count densities and the estimated densities (Table 1). Even though the rank was different, the top three treatments from the count data, were in the first four recommended treatments of estimator B. The net returns from the recommended treatments were similar for both the counts and the estimations. The small differences in predicted net return can be attributed to the differing weed densities and were expected with the equations that are used in HADSS (Wilkerson et al., 1991).

There were no differences between the counts and the estimations, in the bromoxynil-resistant experiment, for pitted morningglory and johnsongrass at Altus (Table 2). The trends noted in the glyphosate-tolerant experiment, when comparing an individual estimator or the average difference of all estimations to the counts, were generally the same in this experiment which had three different estimators. The rank of the recommended treatments from the estimated populations were the same as from the counted population, with only one exception (Table 2). The predicted net returns of the recommended treatments were similar for the estimated and counted weed populations.

The Chickasha experiments revealed similar results (data not shown). Common cocklebur was the only weed species that was evaluated and there were no differences between the counts and the estimations in either experiment. In the glyphosate-tolerant experiment, there were 4.5 weeds while the estimates ranged from 1.6 to 4.8 weeds when only a PPI was used, and with the PPI followed by PRE there were 3.8 weeds in the count and the estimates ranged from 1.9 to 3.3 weeds. The weed population was higher in the bromoxynil-resistant experiment. With only a PPI application the population was 69 in the counts and the estimations ranged from 46 to 56 weeds. With the additional application of prometryn PRE, the weed density in the counts was 35 and the estimations ranged from 20 to 24 weeds. There were no differences in rank of the recommended treatments between the count and the estimations in either experiment. The net returns were similar and any differences could be explained by the differing weed densities input into the program.

Only Palmer amaranth was evaluated in the two cotton experiments at Perkins in 1999 (data not shown). When no PPI herbicide application was applied weed populations were extremely high and were above the HADSS allowable population value of 1000 weeds/9.3 m^2. Therefore no measurable data was taken from these plots. With a PPI application there were no differences between the counts and the estimations in both experiments. In the glyphosate-tolerant experiment the counts were 7.4 weeds and the estimations ranged from 4.2 to 5.2. The bromoxynil-resistant experiment had weed values of 6.8, 4.6, 11.3, and 2.8 for the counts and the estimations, respectively. In the glyphosate-tolerant experiment the recommended treatments 1, 2, and 3 from the counts were ranked 1, 3, and 4, respectively, for all three estimations with similar net returns. The treatment ranks in the bromoxynil-resistant experiment were the same for the count and the estimations by estimators A and B while the top three recommended treatments from the counts were ranked in the top four recommended treatments from the estimations by estimator C. The net returns of the counts were similar for estimator A and C, but estimator B had net returns about $30/ha higher than the counts due to the higher estimated weed population.

There was one glyphosate-tolerant experiment conducted at Perkins in 2000 and entireleaf morningglory and Devil's-claw were evaluated (data not shown). There were no weed density differences between the estimations and the counts for either species in either treatment. Weed populations in the PPI treatment from the counts were 8.4 and 6.0 weeds and the estimations ranged from 4.0 to 5.9 weeds and 4.3 to 8.4 weeds for entireleaf morningglory and Devil's-claw, respectively. In the PPI followed by PRE treatment the entireleaf morningglory count was 2.1 weeds and the estimations ranged from 1.2 to 1.4 weeds and the Devil's-claw count was 8.7 weeds and the estimations ranged from 5.8 to 7.7 weeds. The first three recommended treatments from the counts were ranked 1, 3, and 2 in the estimations recommended treatments for the PPI treatment.

In the PPI followed by PRE treatment the first two recommended treatments were the same for the counts and the estimations; the third recommended treatment from the counts was ranked either fifth or sixth in the estimation recommendations. There were only minor differences in net return.

Table 3 shows data from a peanut experiment at Ft. Cobb in 1999. There were more differences in weed estimations in this experiment than all other experiments combined. The differences can probably be attributed to the high weed population, the multi-species evaluated, and the small weed size at the time of evaluation. Crownbeard, the most populus weed species, had one estimate higher and two lower when no PPI was applied and when a PPI was applied there were two estimations lower. Entireleaf morningglory populations were under estimated in all six estimations. For Texas panicum the three estimations were lower than the weed count in the no PPI treatment and one estimate was higher than the count in the PPI treatment. Palmer amaranth had two estimations higher than the count when no PPI was used and one estimate lower when a PPI was used (data not shown). The estimations were different from the counts in 75% of the estimations across all weed species and both herbicide programs. However, even with this many differences, the top three recommended treatments from the estimations were ranked in the same order as the count recommended treatments 75% of the time. The two estimations that had a different ranking of recommended treatments had the three recommended treatments from the counts ranked in their top four recommended treatments. The predicted net returns were more variable in this experiment than any other; however, this would be fully expected because the weed numbers entered in HADSS would directly alter the economic assessment. The predicted net returns between the counts and the estimations when a PPI was applied were similar but there were large differences when no PPI was used. These differences can probably be attributed to the under estimation of both crownbeard and entireleaf morningglory by the estimator.

In 2000 at Ft. Cobb, entireleaf morningglory and Texas panicum were evaluated (data not shown). There were no differences between the counts and estimations for entireleaf morningglory. The entireleaf morningglory count was 17.8 weeds with flumioxazin PRE and the estimations ranged from 12 to 18.4 weeds and with diclosulam PRE the count was 2.9 weeds and the estimations ranged from 1.3 to 3.3 weeds. Texas panicum weed count population was 24.4 weeds and the estimations ranged from 18.2 to 26.1 weeds with flumioxazin PRE. One estimation, in the diclosulam PRE, of 18 weeds was lower than the count of 37.1 weeds while the other two estimations of 31.9 and 25.2 weeds were not different. The top three recommendations from the counts and the estimations were the same and the net returns were similar.

The peanut experiment at Ft. Cobb in 2001 resulted in no differences in population between the count and the estimations for Texas panicum (data not shown). The counts for Texas panicum were 13.2 and 7.4 weeds with estimations that ranged from 5 to 8.8 weeds and 2.7 to 5.1 weeds, respectively. Crownbeard count populations, in one PRE herbicide program, was 1.5 weeds and not different from two estimations of 1.1 and 2.8 weeds but lower than an estimation of 5.1 weeds. There were no differences between the counts and estimations in the other PRE herbicide program. Entireleaf morningglory, in one soil-applied program, had a weed population from the count of 9.4 weeds while the estimations ranged from 4.8 to 7.7 weeds, with the lowest weed density being different. The other soil-applied program had no differences with a count of 7.1 weeds and the estimations ranged from 4 to 8.5 weeds. The rank of the top three recommended treatments in both soil-applied programs were always in the top five recommended treatments for the estimations.

These results suggest that weeds can be effectively estimated in small sample size areas and the estimations had little effect on the treatments recommended by HADSS when compared to actual count populations. This research confirms the suggestion in the HADSS users guide (Sturgill et al., 2001), that users can estimate weed populations when weed densities are high, but the results also suggests that estimates could possibly be used more often when scouting fields. When scouting fields, users of the program may be able estimate weed populations instead of making actual counts at quadrants throughout the field. If using this method users should be cautioned that the program is only an aid and the top several recommended treatments are generally viable control options. A caution of this work is that the people making the estimations were trained in weed management areas and had experience with properly identifying weed species.

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Table 1. Weed counts and estimated populations of pitted morningglory (IPOLA) and johnsongrass (SORHA) in glyphosate-tolerant cotton. Three postemergence recommended herbicide treatments and rates with the highest net returns, based on weed counts, compared to postemergence recommended herbicide treatments based on estimated weed populations at Altus in 1999.

	Soil-applied herbicide program[a]									
					PPI			PPI fb PRE		
					HADSS recommended POST herbicide treatments based on weed counts					
Source	PPI[c]		PPI fb PRE			Gly (1.1) +	Gly (1.1) +		Gly (1.1) +	Gly (1.1) +
of data[b]	IPOLA	SORHA	IPOLA	SORHA	Gly (1.1)	Carf (0.01)	MSMA (1.1)	Gly (1.1)	MSMA (1.1)	Diuron (1.1)
	#/9.3 m²				Rank and $/ha					
Weed count	118.0	14.6	37.8	2.2	1 273[d]	2 272	3 271	1 292	2 290	3 289
Estimator A	101.0	12.8	35.9	2.5	1 279	2 277	3 276	1 292	2 289	3 288
Esimator B	149.0	32.0	49.6	3.3	2 260	1 259	4 257	1 293	2 291	3 290
Estimator C	117.2	10.9	25.1	2.0	1 274	2 272	3 271	1 284	2 282	3 282
LSD (0.05)	55.2	15.4	22.5	2.6	--	--	--	--	--	--

[a]PPI was trifluralin at 1.1 kg ai/ha and PRE was prometryn at 2.2 kg/ha. All herbicide rates are in kg/ha.

[b]Weed counts were made in every plot, the three estimators, weed science graduate students or faculty members, estimated the weed populations in every plot.

[c]Abbreviations: PPI, preplant incorporated; fb, followed by; PRE, preemergence; Gly, glyphosate; Carf, carfentrazone.

[d]The underlined number represents the rank by counts and the relative rank using the estimators populations, and the net return is the predicted net return from HADSS.

Table 2. Weed counts and estimated populations of pitted morningglory (IPOLA) and johnsongrass (SORHA) in bromoxynil-resistant cotton. Three postemergence recommended herbicide treatments and rates with the highest net returns, based on weed counts, compared to postemergence recommended herbicide treatments based on estimated weed populations at Altus in 1999.

	Soil-applied herbicide program[a]									
					PPI			PPI fb PRE		
					HADSS recommended POST herbicide treatments based on weed counts					
Source	PPI[c]		PPI fb PRE		Bro (0.6)	Pyr (0.07)	Pyr (0.07)	Bro (0.6)	Pyr (0.07)	Pyr (0.07)
of data[b]	IPOLA	SORHA	IPOLA	SORHA	fb Flu (0.1)	fb Flu (0.1)	fb Flu (0.3)	fb Flu (0.1)	fb Flu (0.1)	fb Flu (0.3)
	#/9.3 m²				Rank and $/ha					
Weed count	102.6	20.8	33.1	4.2	1 304[d]	2 291	3 282	1 330	2 317	3 308
Estimator A	99.0	12.8	38.1	2.5	1 310	2 297	3 288	1 332	2 319	3 310
Esimator B	149.5	32.0	52.9	3.3	2 273	1 260	4 251	1 334	2 320	3 311
Estimator C	113.0	10.9	25.7	2.0	1 303	2 290	3 281	1 321	2 308	3 299
LSD (0.05)	51.5	14.9	20.1	2.8	--	--	--	--	--	--

[a]PPI was trifluralin at 1.1 kg ai/ha and PRE was prometryn at 2.2 kg/ha.

[b]Weed counts were made in every plot, the three estimators, weed science graduate students or faculty members, surveyed and estimated the weed populations in every plot.

[c]Abbreviations: PPI, preplant incorporated; fb, followed by; PRE, preemergence; Bro, bromoxynil; Flu, fluazifop; Pyr, pyrithiobac.

[d]The underlined number represents the rank by counts and the relative rank using the estimators populations, and the net return is the predicted net return from HADSS.

Table 3. Weed counts and estimated populations of crownbeard (VEEEN), entrileaf morningglory (IPOHE) and Texas panicum (PANTE) in peanut. Three postemergence recommended herbicide treatments and rates with the highest net returns, based on weed counts, compared to postemergence recommended herbicide treatments based on estimated weed populations at Ft. Cobb in 1999.

	Soil-applied herbicide programs [a]											
							No PPI			Ethalflurafin 0.8		
							HADSS recommended POST herbicides based on weed counts					
	No PPI			Ethalflurafin 0.8								
Source of data[b]	VEEEN	IPOHE	PANTE	VEEEN	IPOHE	PANTE	Par + 2,4-DB	Par + Bent + Acif	Par + Bent + 2,4-DB	Par + 2,4-DB	Par + Bent + Acif	Par + Bent + 2,4-DB
	(#/9.3 m²)						Rank and $/ha					
Weed count	97.9	88.9	49.9	74.6	37.6	15.7	1 440[c]	2 354	3 289	1 551	2 483	3 467
Estimator A	59.5	42.7	8.9	30.5	28.5	5.9	1 582	2 543	3 542	1 553	4 520	2 526
Estimator B	121.8	63.0	19.8	81.5	28.0	9.4	1 524	2 485	3 461	2 563	1 491	4 483
Estimator C	62.3	64.8	20.4	41.3	29.0	5.5	1 549	2 507	3 483	1 581	2 540	3 538
LSD (0.05)	21.5	16.1	14.5	19.1	8.1	5.4						

[a]Soil-applied herbicides were applied PPI and are followed by their respective rates in kg ai/ha. Acif, acifluorfen applied at 0.3 kg ai/ha, Bent, bentazon applied at 0.6 kg ai/ha, Par, paraquat applied at 0.3 kg ai/ha, and 2,4-DB was the isopropyl salt applied at 0.01 ha ai/ha.

[b]Weed counts were made in every plot, the three estimators, weed science graduate students or faculty members, estimated the weed populations in every plot.

[c]The underlined number represents the rank by counts and the relative rank using the estimators populations, and the net return is the predicted net return from HADSS.

VITA 2

Shea William Murdock

Candidate for the Degree of

Doctor of Philosophy

Thesis: ADAPTATION AND VALIDATION OF A COMPUTERIZED DECISION SUPPORT SYSTEM FOR COTTON AND PEANUT PRODUCTION IN OKLAHOMA

Major Field: Crop Science

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